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AGRICULTURAL ADVISORY DEPARTMENT.

WHEN the West Indian Agricultural College was started in 1922, the Staff, both for teaching and executive work, consisted for the most part, of members of the former Imperial Department of Agriculture. The functions had been taken over by the College when the latter came into being. The name of the new Institution was soon changed to the Imperial College of Tropical Agriculture. It has now been decided that there shall be a separate department or section of the College to deal with extension work and that it shall be termed the Agricultural Advisory Department of the Imperial College of Tropical Agriculture. The executive control will be in charge of a Commissioner, who will come under the Principal as head of the College and consult him on all matters of policy.

The Imperial Department of Agriculture was established with headquarters at Barbados, as the result of the visit of the Royal Commission to the West Indies in 1896-97, and began work in October, 1898, with Dr. (now Sir Daniel) Morris, as Commissioner of Agriculture. During the ten years of Sir Daniel's regime, the Department was in administrative control of considerable imperial funds which were allocated to certain of the West Indian Colonies. When Dr. (now Sir Francis) Watts became Commissioner in 1909, these grants were diminishing year by year until about 1913-14, when they ceased, and subsequently each Colony had to maintain its Department of Agriculture from its own funds. The administrative control vested in the Imperial Department related only to the smaller Islands, in which the Government resources were insufficient to permit of the employment of specialist officers. The larger Colonies, in which specialist officers such as Mycologists, Entomologists and Chemists, were employed, came into a consultative relationship with the Imperial Department.

When the Imperial Department of Agriculture became the West Indian Agricultural College, its Staff included Sir Francis Watts, who added to his duties of Commissioner, those of Principal of the College; Mr. H. A. Ballou, Assistant Commissioner and Entomologist; Mr. S. F. Ashby, Mycologist; Mr. W. R. Dunlop, Scientific Assistant; Mr. F. Hardy, Chemist and Soil Scientist; and Dr. T. G. Mason, Plant Physiologist

The work of organising and developing the teaching courses and other College activities, occupied fully the time and energies of the Principal and his Staff.

In 1927 it was decided to establish a separate section of the College to deal with the functions of the Imperial Department. Mr. Ballou undertook the duties of Commissioner, so far as they applied to the Windward and Leeward Islands, in addition to his duties as Professor of Entomology. To cope with the increased activities of the Department, Mr. G. A. Jones was appointed Assistant Commissioner in 1929. Although the Staff consists only of the Commissioner, the Assistant Commissioner and a Clerk, the entire College Staff co-operates to the fullest possible extent. The duties of the Commissioner are to maintain a liaison between the College and the several Colonies, to advise local Governments in matters of agriculture, and to function as adviser to the Colonial Office on such West Indian matters as may be referred to him. In the early days of its existence, the Imperial Department of Agriculture organised agricultural conferences, planned manurial and other experiments with all the staple crops, and introduced planting material from which major or minor crops might be developed. It established agricultural schools, provided science masters for Grammar Schools, published the *Agricultural News* and *West Indian Bulletin*, and a series of pamphlets and handbooks. Cattle, horses and other stock were introduced, and made available for the improvement of the local breeds.

In more recent years conditions have changed and the period of reconstruction during the post-war depression has been particularly trying. The prices of agricultural products have fallen heavily, the outstanding exception in the West Indies being limes and lime products. This, however, is the outcome of adversity, Wither-Tip and Blossom Blight diseases having seriously curtailed the lime crops of St. Lucia and Dominica in recent years, while Red Root disease in Dominica has also caused the death of a large percentage of the trees which promised to be profitable after the establishment of the Wither-Tip fungus in that Island. In Montserrat, lime cultivation had made good recovery after the storm of 1924, but the 1928 storm destroyed most of the lime trees that were large enough to be affected by it, and Dominica also suffered severely from the same cause. This shortage in the supply of West Indian limes has resulted in high prices, but, quite recently, lime products have followed the general trend of other tropical produce and declined in value. Lime oil, however, both handpressed and distilled, has for some time past realized high prices and this factor has proved of the greatest benefit to lime growers. For several years Sea Island cotton has suffered from comparatively low prices. At the present time the sugar industry is faced with the most serious crisis in its history.

In spite of its inadequate Staff the Imperial Department has been able to assist several of the Windward and Leeward Islands during the past few years, by arranging for visits by members of the College Staff. For example, in 1926, Dr. Briton-Jones visited St. Lucia to investigate and report on the outbreak of Wither-Tip of limes, and in 1927, the persistent spread of Red Root disease of limes was the occasion of another visit by him to Dominica. In 1927, Professor Cheesman visited Montserrat, and, in 1930, St. Vincent, in connection with the quality of the cotton seed supply available to planters in those Islands. Mr. Croucher visited St. Lucia in 1928 and made an examination of certain sugar-cane soils. Mr. Wright visited St. Vincent in 1928 and made a study of the economics of the cotton and other agricultural industries of that Colony. Through the co-operation of the Imperial Bureau of Mycology, Professor Ashby visited Dominica for a further study of Red Root disease. He also visited Antigua, where he found Gummosis in sugar-cane. On Professor Ashby's recommendation the Commissioner of Agriculture was able to arrange for an investigation to be made into the status of this disease in Antigua. Visits such as these would be automatically provided for with an adequate Staff, without tending to dislocate other College activities.

The Commissioner and Assistant Commissioner have paid frequent visits to the several Islands for the purpose of advising on agricultural matters, and correspondence is constantly being exchanged in this connection with the administrative and agricultural officers in the Colonies, and, through the Principal, with the Colonial Office. Consequent upon the improvement in shipping communications, provided by the new steamers of the Canadian National Steamships Company, a substantial start is being made in the development of a fruit and vegetable trade with Canada. The success so far attained reflects considerable credit on the energy and enthusiasm of the administrative and agricultural officers in the several Islands. The cotton growers of St. Vincent suffered considerable losses as a result of what appeared to be a wrong planting season. The Commissioner of Agriculture, during a visit in 1929, persuaded the cotton growers to adopt a different planting season, and the results of the first season, 1929-30, indicate that the change has been beneficial. Mr. G. A. Jones has been engaged in investigating and reporting on agricultural conditions in the various Islands. He was attached to the West Indian Sugar Commission from October to January as Agricultural Adviser where his great knowledge of the sugar-cane industry and of West Indian conditions undoubtedly proved of great value to the members of the Sugar Commission.

Advice is constantly being sought on matters of policy regarding pests and diseases, supplies of seed-planting material on chemical and soil science subjects, and economic problems. A cotton breeder has just been appointed for

St. Vincent by the Empire Cotton Corporation and for administrative purposes assigned to the Advisory Department of the College. The cotton station at St. Vincent which has been closed for about four years, is to be re-opened in co-operation with the St. Vincent Government. Dr. S. C. Harland has been appointed Cotton Adviser to the Department and will direct the scientific work of the cotton officer, St. Vincent, through the Commissioner of Agriculture. The publication branch of the old Imperial Department is now being continued under the Imperial College of Tropical Agriculture. The College Journal, *Tropical Agriculture*, with its Memoirs, provides opportunities for publishing results of investigations and for the dissemination of agricultural news.

The Imperial Department of Agriculture for the West Indies has a long and honourable record behind it and can justly claim to be one of the pioneers of agricultural research in the tropics. As the Agricultural Advisory Department of the Imperial College of Tropical Agriculture it has now received a new lease of life and, with the programme of extension now under contemplation by the Secretary of State and the College authorities, it should soon be in a position to considerably expand its activities to the mutual benefit of all the Colonies in the Eastern Caribbean area.

SOUTH AFRICAN SUGAR.

Eighty Years' History.

[*Abridged from the "South African Sugar Year Book and General Directory*, 1930."]

THE founding of the industry is ascribed to Mr. Morewood who planted several acres of cane at Compensation Flats, near Umhlali, in the year 1848. It was two years later that the first sugar was actually produced in South Africa. Up to 1887 the canes commonly grown were "Green Natal," "Bourbon," "Gold Dust" and "Louisier." It is believed the variety now known as "Green Natal" is descended from the indigenous plant. Then disease threatened the destruction of the industry, but the Government displayed proper solicitude and assisted the importation of canes from Java, the West Indies, Mauritius and India.

In 1852, plantations were started in the Isipingo district through the enterprise of Messrs. Platt, Burkett & Mack, who obtained four varieties of cane from Compensation Flats. This district soon became an important centre of the young industry and by 1858 there were 12 sugar mills and 1,500 acres under cultivation in Durban County. The progress of the industry was slow at first due chiefly to the difficulties of transport, labour, and the primitive machinery that was used. Labour was perhaps the worse trouble because of the intermittent supply. This was remedied in 1860 by the introduction of Indian coolies, and by 1866, 5,600 had been imported when financial consideration compelled a stoppage of the supply, and it was not resumed until 1874.

In the year 1855, steam was introduced into one of the mills, and the first centrifugal machine was installed. 1864 saw an important advance in output, and five years later, 7,800 tons of sugar were produced together with 34,700 gallons of rum. About 1877, some Mauritian planters immigrated to Natal bringing with them some expert sugar makers. At the same time the first big sugar mill was erected at Mount Edgecombe with a capacity of 20 tons of sugar a day. This factory has now grown to one capable of producing approximately 33,000 tons of high grade white sugar per season. Up to this time, internal transport was by means of ox-wagons, but the opening of the railway from Durban to Verulam in 1879, and to Mauritzburg in 1880, inaugurated a new era. Further development took place with the extension of the railway from Mauritzburg to the border.

In 1888 another scarcity of labour was experienced as the gold fields were attracting the natives and railway extensions were absorbing not only natives but Indians. Consequently a meeting of planters was held and it was unanimously resolved that more labourers be obtained from India. The cost was reckoned at £27 10*s*. 6*d*. per male adult. In recent years these coolies have been almost entirely supplanted by Kafirs, and before long Europeans will be utilised for all semi-skilled work both in the fields and factory. Centralizing of mills was the next step forward. In 1892, there were 36 factories working in Natal which have now been reduced to 24, together with one refinery.

Among adverse influences affecting the industry of later years, the most important was necessarily the great fall in the market price of sugar in 1883-84. This caused one or two estates to go out of cultivation but the rest survived, due to greater economy being exercised and better machinery being installed. To-day, South African mills are equipped second to none. There are 1,000 square miles of cane and during the cutting season there are handled 3,000,000 tons of trashed cane. The total capital employed is £6,000,000 and the number of persons actively engaged exceeds 60,000. The importance of the industry does not end in the value of the figures displayed, for it is the foundation of sister industries such as jam, canned fruit and confectionery manufacture.

Development of Zululand.

The sugar industry also played a prominent part in the development of Zululand. In 1897, this country was annexed to Natal, European settlement was slow at first but when the enormous potentialities of the country were realized, a steady migration resulted. Irrigation schemes were carried out and vast tracts put under cultivation. It is a land with a great future and so long as cane flourishes there will always be prosperous settlements. If cane should fail, other prosperous agricultural industries will spring up and take its place.

J. G. D.

THE OIL PALM INDUSTRY.

By S. M. Gilbert,
Assistant Director of Agriculture, Trinidad.

[*The following article is based, as regards the Belgian Congo, on notes made by the writer in* 1928, *when he was privileged to spend some months on "study leave" in that country. As Superintendent of Agriculture in Southern Nigeria from* 1923-1929 *he gained a working knowledge of the oil palm industry in West Africa. Statements in regard to the industry in Sumatra and Malaya are based on the reports of Messrs. Auchinleck and Waters, to whom acknowledgment is hereby made, who visited these countries on behalf of the British West African Governments in* 1926.]

General.

The palm oil and kernels of commerce are obtained from the fruit of a palm known botanically as *Elaeis guineensis*. The fruit is borne in bunches commonly weighing about 20 lb. each. Of a bunch about 50 per cent. is fruit. The remainder consists of stalks and bracts. Male and female inflorescences are separate. A fruit consists roughly of a nut surrounded by a fleshy oil-bearing "pericarp." Palm oil is obtained from this outer layer whilst the nut is broken to obtain the kernel. The oil content of common fruit is about 20 per cent. of the weight of the fruit. The kernel accounts for about ten per cent. of the fruit. Great variations exist. For example, the writer knows of one type—Afia Oku Eyop (Efik language of Southern Nigeria)—which yielded 55 per cent. oil to fruit on analysis. Similarly another type contained no kernel whatsoever. A typical analysis of common fruit from South-East Nigeria is :—

Typical analysis of common palm fruit.

Bunch	100
Fruit	50
Pericarp	21.5
Fibre	(10.5)
Oil	(11.0)
Nut	28.5
Kernel	(6.2)

In the same way the weight of fruit per tree varies considerably. Figures for wild palms are difficult to obtain and convey little. It may be of interest to state that a batch of some 300 trees tested by the writer only averaged about 40 lb. of bunches, giving approximately 20 lb. of fruit and, by native methods of extraction, 2 lb. of oil per tree per annum. On the other hand, plantations in the East are alleged to give 1,000 lb. of oil per acre with palms spaced 30 feet apart. Nevertheless the West Coast of Africa continues to supply the bulk of the world's requirements of palm oil and kernels, see table below :—

Exports of Palm Oil and Kernels for 1929.

Country.	Palm Oil.	Palm Kernels.
	tons.	tons.
Nigeria ..	131,845 [1]	251,477
Belgian Congo ..	27,768	72,240
Sumatra ..	20,000 [2]	5,000 [2]
Malaya ..	2,000 [2]	300 [2]

The "menace" from the East (Sumatra and Malaya) is not discussed to the same extent as formerly. The fact remains, however, that the West Coast cannot supply the large quantities of clean palm oil of *uniform grade* that the trade is demanding.

It is interesting to consider the ways in which various countries are attempting to meet the requirements. The three factors that usually control the methods adopted are :—

1. **Presence or otherwise of wild palms in quantity.**
2. **Land tenure.**
3. **Labour.**

In West Africa large tracts of wild palms exist. Communal land tenure hinders the development of large plantations. A dense population has to be supported. The means of extraction of the oil are very primitive. In the East no wild palms exist. Land tenure permits of large plantations being developed. Labour is fairly plentiful and cheap. In the Belgian Congo large areas of wild palms are found in very sparsely populated areas at a great distance from the sea. Up-to-date methods of extraction have been adopted by exploiting companies. Under existing conditions it is not likely that plantations of oil palms will be established to any large extent in either the Congo or West Africa. These countries will continue to depend then on wild palms—improved perhaps by removal of foreign growth and by thinning and re-planting of existing palms—for supplies for the extraction plant.

The following columns serve to clarify the comparative position in the two African areas.

West Africa.	*Belgian Congo.*
1. Dense population.	Sparse population.
2. Oil palms in coastal belt and owned by the African.	Oil palms mainly far inland (except in Mayumbe) and exploited by outside companies.
3. Primitive extraction by peasants.	Efficient extraction by modern mills.

(1) It is estimated that almost an equal quantity is consumed locally.
(2) Estimate.

THE OIL PALM INDUSTRY.

FIG. I.—*Loading produce on sternwheeler of the Huileries du Congo Belge fleet on the Congo River at Kinchasa.*

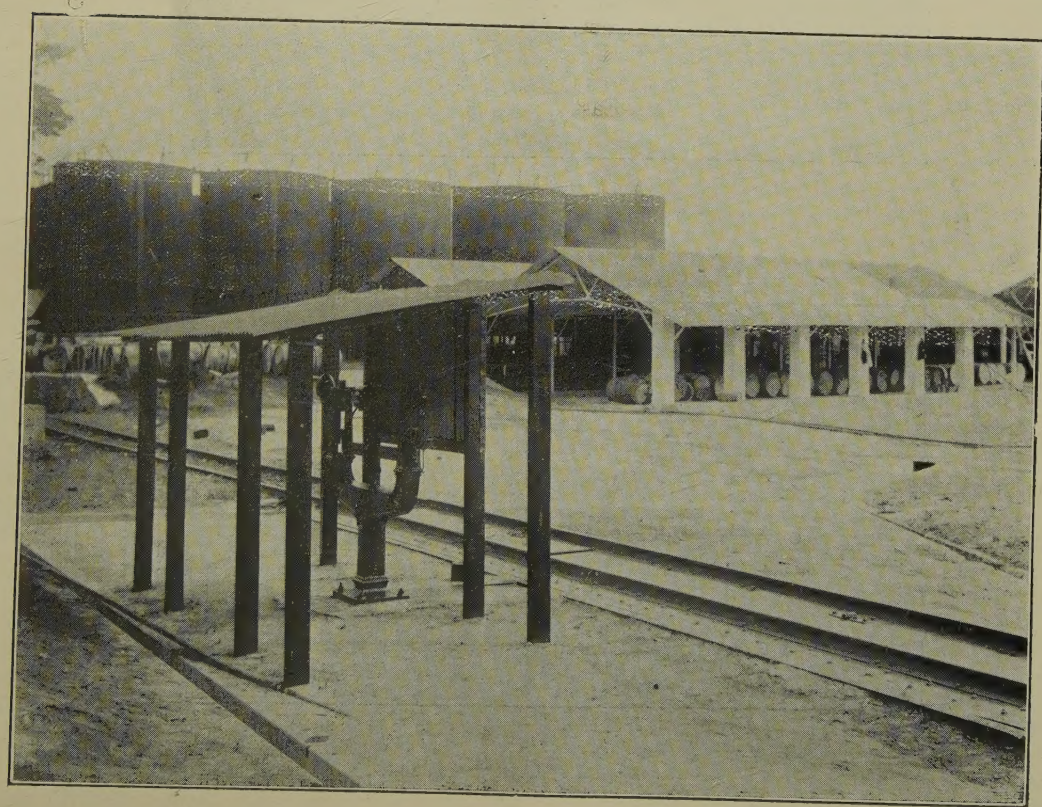

FIG. II.—*Battery of storage tanks for palm oil, Kinchasa, Congo Belge. In foreground automatic weighing machine for palm oil drums.*

THE OIL PALM INDUSTRY.

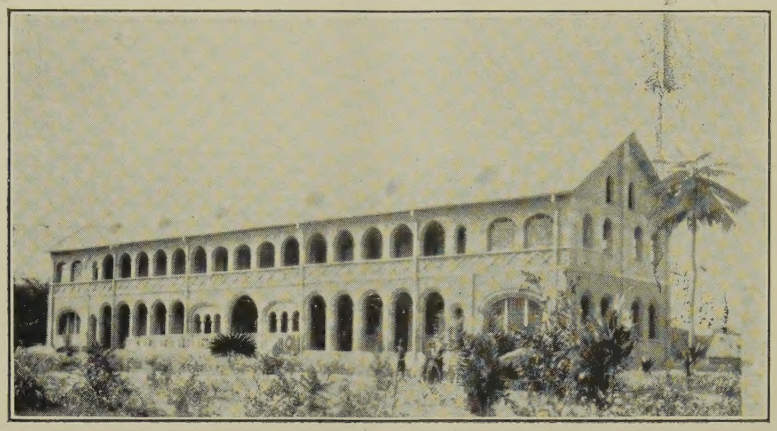

FIG. III.—*Quarters of the Huileries du Congo Belge Educational Staff at Leverville.*

FIG. IV.—*A small type mill ,successfully developed by the Huileries du Congo Belge.*

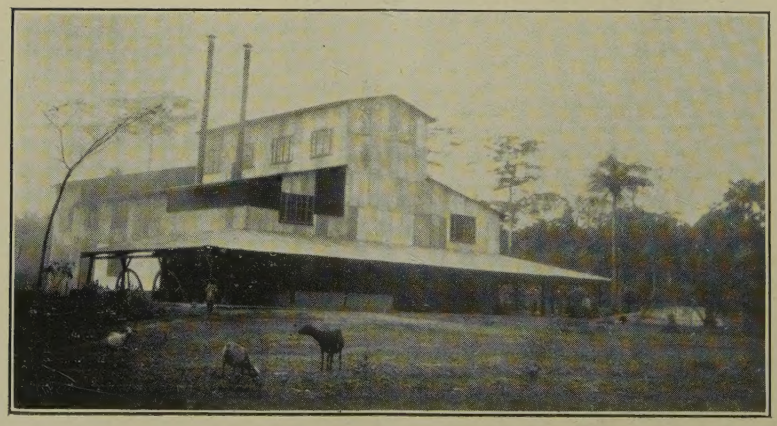

FIG. V.—*A large type "wet process" mill near Stanleyville, Central Africa.*

In West Africa the problem is to obtain better means of extraction. In the Congo the limiting factor is labour.

The position in the various countries will now be considered in more detail, and in three broad divisions :—

1. Production of fruit.
2. Extraction.
3. Transport.

Belgian Congo. This vast country is situated on both sides of the Equator between 5° North and 12° South in latitude, and between 12° and 30° East in longitude. It has an area of approximately 900,000 square miles with a population of only about 9,000,000 souls. It is thus readily seen that the exploitation of vast areas by outside interests need not inflict any hardship, as regards land, on the indigenous population.

The main means of evacuating produce continues to be by the Congo River and its tributaries to Leopoldville, thence by rail round the rapids to the seaport Matadi. Most of the best productive areas lie over 300 miles from the port and involve frequent handling of cargo. Freight from forest to sea is, therefore, high.

The production of palm oil in the Congo is mainly in the hands of the Huileries du Congo Belge, a subsidiary of Messrs. Lever Brothers. In 1928 the writer was, by courtesy of the Belgian Government and Messrs. Lever Brothers, permitted to visit and examine in detail, on behalf of the Nigerian Government, the vast and up-to-date workings of this company.

Messrs. Lever Brothers' association with the Belgian Congo began in 1911, when, following on the slump in rubber, the Belgian Government asked the late Lord Leverhulme (then Sir William Lever) for his assistance in organizing the oil palm industry in the interior of the Belgian Congo. In due course an agreement was signed which resulted in the formation of the Huileries du Congo Belge. Five large concessions were given in various parts of the country, each of a radius of approximately 40 miles. Ten years were allowed in which to decide on the areas.

Providing the conditions then laid down are fulfilled, up to 40,000 hectares in each of the five areas may become the freehold property of the Huileries du Congo Belge. The conditions laid down provide for a fixed minimum of development in production of oil and kernels and set forth most elaborate details for ensuring the welfare of the native population. These latter conditions, of which more anon, are fulfilled most liberally by the firm.

1. Production.

Fruit is obtained from the following sources :—

(*a*) from the concessions
  (1) by hired labour.
  (2) by purchase.
(*b*) from outside the concessions by purchase.

In the concessions there is a definite scheme of improvement of the natural palmeries by thinning and replanting.

In the natural state wild palms are found in varying densities in mixed rain forest and in the valleys of undulating "savannah" country. There is some evidence to show that the denser "groves" are on the site or in the vicinity of abandoned villages or "camps" where there would be every facility for palm seeds to germinate and develop.

Obviously it would occur to any investigator, anxious to secure the maximum yield of fruit at once from any given area, to consider the possibilities of improving the yield of existing palm forests before attempting the establishment of regular plantations on cleared land at enormous expense. It is important to bear in mind that a serious fall in yield during the period of improvement must be guarded against, as anything that would prevent a mill from running at full capacity would add to the cost of production. This means, in practice, that trees in full bearing must, in the main, be left standing whilst provision must also be made to have young trees coming on as replacements.

The method adopted by the Huileries du Congo Belge is as follows. First the undergrowth is cut down and "foreign" trees carefully felled and the material destroyed by burning. This enables a thorough inspection of the palms standing to be made. Very old palms, non-bearing palms and certain others are then felled to leave a stand of vigorous, healthy bearing palms at, approximately, a distance of 25 feet apart. Selected young palms, in suitable situations, are also left. In spaces devoid of palms young ones are planted up in line at from 25 feet to 30 feet apart each way, according to the soil conditions. The land is sometimes cultivated and whenever possible a cover crop is put in. Frequently a species of Paspalum has been used for this purpose in order to provide cattle grazing. Supplies are obtained from nurseries established for the purpose.

Nurseries.—These are planted from selected seed. Bunches of not less than 22 lb. weight are chosen and the fruit must contain not less than 75 per cent. of pericarp. Germination of the seed is hastened by planting the seeds in a stout wooden box holding about 1 cwt. of fruit, sprinkling with water, covering with a layer of leaves, finally with sacking, and then leaving for two to three weeks. The rise in temperature is said to hasten germination.

Harvesting.—The bunches are cut, as in West Africa, by a man climbing the palm with the aid of a rope and the bunch and the leaves in whose axil it rests are removed by a machete. It is estimated that an average cutter will harvest and carry to the collecting point, not more than half a mile away, about ten bunches a day. He should earn about one shilling by this work.

Transport from palmery to mill is very well organized and may involve several means, for example, canoe, launch, steamer, railway or lorry. It is quite common for bunches to be headed to a collecting station, then sent by lorry to a point on a river and thence by small steamer to the mill.

The company aims at reducing head transport to a minimum and at getting the fruit from tree to mill with the least possible delay. Only by this means can deterioration in fruit and subsequent rise in free fatty acid be prevented.

Labour Conditions.—Among the obligations of the company are definite lines of conduct towards their employees, laid down by the Belgium Government. These obligations entail the provision of very adequate housing, a ration of minimum food value, clothing, schools, hospitals and medical services, and repatriation. The photographs show in what liberal fashion the Huileries du Congo Belge has interpreted these conditions.

In **Nigeria**, especially in Calabar Province, there are extensive areas of "groves" consisting almost entirely of oil palms. The writer saw nothing approaching this in Belgian Congo. At present the "improvement" of palm forests in this colony is entirely in the experimental stage.

After rather uphill work in connection with the difficulties of overcoming native suspicion, conditions of land tenure, &c., the writer was able to initiate eleven sets of experiments in different parts of the Eastern Province of Southern Nigeria on methods of improvement. The experiments are carried out on the farmer's land at his own expense, but under the guidance and supervision of the local Department. The produce, of course, continues to belong to the owner. In practice the problem has turned out to be one of converting natural palmeries gradually into plantations, without sacrificing any appreciable fall in yield.

There are indications of success, as may be seen from the table below taken from the Annual Report, Department of Agriculture, Nigeria, for 1928 :—

Area.	Treatment.	Yield of bunches per acre.
		Lb.
A.	6 plots, each 1 acre, in bush ..	2,081
	5 plots, each 1 acre, cleared and thinned and replanted where necessary	3,043
B.	6 plots, each 1 acre, in bush ..	2,388
	5 plots, each 1 acre, cleared and thinned and replanted where necessary	2,550
C.	5 plots, each 1 acre, in bush ..	1,086
	4 plots, each 1 acre, cleared and thinned and replanted where necessary and farmed	1,464
D.	4 plots, each 1 acre, in bush ..	1,060
	3 plots, each 1 acre, cleared and thinned and replanted where necessary and partly farmed ..	1,575
E.	4 plots, each 1 acre, in bush ..	1,214
	3 plots, each 1 acre, cleared and thinned and replanted where necessary	1,515
F.	5 plots, each 1 acre, in bush ..	705
	4 plots, each 1 acre, cleared and thinned and replanted where necessary	922
G.	5 plots, each 1 acre, in bush ..	457
	4 plots, each 1 acre, cleared and thinned and replanted where necessary	1,035
H.	5 plots, each 1 acre, in bush ..	1,401
	4 plots, each 1 acre, cleared and thinned and replanted where necessary	2,259
J.	5 plots, each 1 acre, in bush ..	1,333
	4 plots, each 1 acre, cleared and thinned and replanted where necessary and farmed	1,399
K.	2 plots, each 1 acre, in bush ..	804
	2 plots, each 1 acre, cleared and thinned and replanted where necessary	1,353
L.	2 plots, each 1 acre, in bush ..	1,160
	3 plots, each 1 acre, cleared and thinned and replanted where necessary	1,623
M.	4 plots, each 1 acre, in bush ..	1,053
	3 plots, each 1 acre, cleared and thinned and replanted where necessary	1,559

It is, however, too early to draw any definite conclusions. It is certainly evident that the young palms readily respond to care and treatment during the first few years.

It is interesting to realize that the system of "improvement" of palm groves, as opposed to the establishment of plantations, imposed on Nigeria by reason of its communal "land tenure" and by the adoption of the fixed principle that the land belongs to the African, is also accepted by successful companies in the Congo as best adapted to their needs although land is readily available for plantations.

The East.—On the other hand, in the East, where the palm was introduced from Africa, it has been necessary to establish plantations and at large cost. The average cost of bringing an oil palm estate in Malaya to bearing, not including the factory, is about £40 per acre.

Transport in Nigeria consists merely in "heading" bunches from the communal forests to the village as only one mill is, at present, in existence—at Ibagwa in Calabar Province. In Sumatra harvesting is done by the aid of an axe, and, occasionally, with the use of short ladders. The system of transport to the mill is very highly developed indeed. At up-to-date factories the bunches are conveyed from plantation to mill in steel basket trucks, the loaded trucks are lifted, weighed and packed in large chambers where the bunches are sterilized.

II. Extraction.

Whatever the method adopted for growing palm fruit, as described in section 1, the ultimate aim is to obtain the pericarp oil and the kernels. Systems vary in the different countries, but the methods adopted may be grouped into two broad sections :—

A—Primitive hand methods.
B—Mechanical methods.

Unquestionably machinery is the most efficient way of performing this work. Machinery, however, involves capital and in the case of small growers of fruit this would probably entail co-operation. Nigeria is hardly ripe for the latter. The present position in **Nigeria** is that the bulk of the palm oil produced, both for export and the almost equally large local consumption, is obtained by primitive and wasteful hand methods. Two main methods prevail giving respectively :—

(*a*) hard oil ; (*b*) soft oil.

It is necessary, here, to explain shortly what these terms mean.

Palm oil consists essentially of tri-glycerides of several fatty acids, of which palmatic acid is the chief. This oil is capable of being hydrolysed by certain enzymes which are present in the pulp of the fruit. The products of the reaction are free fatty acids (F.F.A.) and glycerol. The action of such enzymes is very rapid after the bunch becomes ripe especially if oil cells are ruptured by bruising, for example, when the bunch falls in harvesting. The problem is to inhibit this enzyme action at the earliest possible moment. Delay will increase F.F.A. and lead to the production of a "hard" oil. Prompt treatment will minimise the formation of F.F.A. and enable a "soft" oil to be produced.

"Soft" oil is usually made throughout Nigeria for the purpose of local consumption only and in some districts for export purposes. It has been found, however, that the "hard" oil process requires less labour per unit of oil extracted than that for the "soft" and as very little, if any, premium is offered for "soft" oil over "hard" it is natural that the natives should not produce the better type for export.

The essentials of the two processes are :—

(*a*) "*Hard*" *oil process.*—The pulp is rendered sufficiently soft to be readily removed by pounding or treading, by allowing the fruit to lie and ferment for a few weeks. This is usually done in a canoe-shaped receptacle slightly sloping downwards. When the pulp is sufficiently soft, the mass is squeezed by treading or by pestles. After a further interval of a day or so the mass, which has been covered to keep up the heat, is again mashed. The next operation is to add hot water and then again mash. Oil is slowly running down the "canoe" bottom during these operations. Next the mass is treated with cold water and roughly divided up into fibre and nuts whilst a little oil is still running out. The oily liquid so collected from the various operations is heated to drive off the water, skimmed and strained. The nuts are dried for several weeks to shrink the kernel and await a convenient time for cracking.

(*b*) "*Soft*" *oil process.*—The essence of this method is to take the ripe unbruised fruit and by a mixture of boiling and steaming in a pot to kill the lipolytic enzyme and soften the pulp. The hot mass is then pounded in a pestle and mortar, and the nuts picked out. The oil containing fibre is then squeezed by hand, sometimes with the aid of hot water. The oil so obtained is "cooked," strained and skimmed as above.

(*c*) *Nutcracking.*—When thoroughly dry and at a time suitable to the domestic arrangements the nuts are cracked by the most convenient available means—usually the nut is rested in a hole that has been worn in a piece of hard wood or stone, then struck with a piece of iron.

The above methods result in samples of oil and kernels that are often very dirty and contain much extraneous matter. Further, probably 40 or 50 per cent. of the total oil content is lost, for example, 100 per cent. equal fruit ; 20 per cent equal oil content ; 10 to 12 per cent. equal amount of oil obtained by native methods.

It is now necessary to consider the chief milling systems.

Much controversy still rages as to which of two methods is the more efficient. The Belgian Congo, except for one case mentioned later, has pinned its faith to the centrifugal method whilst Sumatra has adopted the hydraulic press.

It has been commonly accepted that fruit containing a "pericarp" rich in oil, say over 25 per cent. oil to fruit, is especially suited to the "hydraulic press" method, whilst fruit of poorer oil content is better dealt with by the "centrifuge." It is a curious fact, nevertheless, that a very efficient firm in Mayumbe, Belgian Congo, is persisting with the hydraulic press although the fruit of that area is notorious for its poor oil content.

Each of the two methods mentioned will now be briefly described.

(1) Centrifugal Method.

The essentials of this process are :—

(*a*) Separation of fruit from bunch.
(*b*) Steaming of fruit.[1]
(*c*) Digestion in which pericarp is removed from nut by beaters.[1]
(*d*) Spinning in centrifugal to extract oil.
(*e*) Removal of nuts from fibre by screening.
(*f*) Re-heating of fibre and 2nd centrifuge.[2]
(*g*) Cleaning of oil by steam and settling.
(*h*) Drying of nuts.
(*i*) Cracking of nuts.
(*j*) Separation of kernels.
(*k*) Bagging.

This method is divided into "wet" and "dry" processes. In the former water is copiously used whilst in the latter steam is mainly used. Both give good results but the former is rather "messy."

(2) Hydraulic Press Method.

The following are the chief stages :—

(*a*) Sterilizing of bunches.
(*b*) Stripping fruit from bunches.
(*c*) Cooking.

1—(*b*) and (*c*) are sometimes combined.
2—(*f*) is sometimes omitted.

(*d*) First pressing in double acting hydraulic press.
(*e*) Centrifuging.
(*f*) Separating nuts from fibre.
(*g*) Second pressing.
(*h*) Benzene extraction of fibre—possibly.
(*i*) Drying nuts.
(*j*) Cracking nuts.
(*k* Separation of kernels.
(*l*) Cleaning of oil.

Various modifications of this process occur.

The question of capacity of mills is one that has caused a lot of controversy. It would seem that the size must depend to a great extent on the efficiency of transport from tree to mill. The main point is to get fruit from tree to mill with as little delay and damage as possible. Under plantation conditions there is a concentration of supplies of fruit close to the factory and presumably the system of transport is well organized. Sufficient capital is also probably available for a large installation. In this case, owing to the slightly better extraction efficiency it is probably best to have a large sized plant.

At the opposite extreme is the case of the extensive forests with palms of low density, where means of transport involve heading for certain sections, and capital is not risked too freely. In these circumstances a smaller mill, even though involving a slight loss in efficiency, would be infinitely preferable. The Huileries du Congo Belge has evolved such a mill and several are working now successfully in Belgian Congo. They are of the centrifugal type and can deal with one ton of fruit an hour. With careful supervision 85 per cent. of the pericarp oil is extracted, that is, with ordinary Belgian Congo fruit about 19 per cent. oil to fruit would be obtained. In practice such a mill turns out about 600 tons of oil per annum. It costs about £4,000 to erect.

Some advantages are :—

(*a*) The necessary fruit could be obtained from rich palmeries within a two-mile radius, thus enabling fruit to be dealt with promptly and with little damage. All transport, other than heading, would be unnecessary.

(*b*) A well trained African could be taught to run this simple type.

(*c*) The mill is sufficiently small and so constructed as to be easily transportable to relatively inaccessible areas.

III.—Transport.

In this section we are dealing with oil and kernels after extraction. Conditions of transport in the **Belgian Congo** are probably more advanced in respect to the handling of palm produce, than in any other part of the world.

Whenever possible the mills of the Huileries du Congo Belge are located near a navigable waterway. In practice this means the Congo and its tributaries. In a few cases mills have had to be erected in natural palmeries some miles from a waterway. In such circumstances road transport links mill with waterway.

At the mill the cleansed oil is run into storage tanks to await shipment. The finest oil, probably containing about two per cent. free fatty acid only, is usually transported in steel drums to its destination. Ordinary oil is pumped from the storage tanks to tank barges which are built to take the products of a consignment of fruit roughly in the proportion in which they are extracted, that is, two parts of oil to one of kernels (fruit 100 per cent. = oil 20 per cent. + kernels 10 per cent). Thus the latest barges hold 200 tons of oil and 100 tons of kernels.

On arrival at the concentration point and headquarters of the river fleet, Leopoldville Est (Kinchasa), the produce is again stored, the kernels in dry lock up sheds into which they are run on tramways, and the oil in tanks into which it is pumped. The total capacity of the tanks at Leopoldville Est is some 2,000 odd tons. (See photograph.) If necessary the oil is again purified here. Briefly the process involves washing, in water tanks into which steam passes, and settling. A set of three cocks provides for testing and running off of the clean oil.

From this point a railway journey is necessary to avoid the rapids and to reach Matadi, the seaport. Twenty-ton tank wagons take the oil whilst the kernels are packed in water tight trucks.

At Matadi another battery of tanks is capable of storing over 2,000 tons of oil. The oil is pumped from these tanks by four-inch pipes to the steamer. Occasionally a steam coil, situated near the bottom of the tank, is turned on to liquify the oil but usually this is not essential.

In these days motor vessels, specially fitted with tanks for carriage of palm oil in bulk, are available but until the last few years fuel tanks were cleaned and used. First class soft oil still goes in drums from the Congo.

In **Nigeria** great progress is being made with the installation at the ports, of plant to handle oil in bulk. Owing to the inferior quality of West African oil, especially in regard to impurities, settling brings down a sludge which is very difficult to remove. Improvement in quality and the use of cleaning and settling tanks are gradually removing this handicap. Puncheons, made of hardwood staves, which latter arrive in West Africa in bunches known as "shooks," are still used to a large extent. In the **East** bulk shipment of oil is, also, still in its infancy.

IV.—Conclusion.

From the above sections it will be seen that very different conditions obtain in the three main productive areas considered. The one that is of greatest interest, from the Colonial Empire point of view, is West Africa. Nigeria is tackling the problem of improvement of its palm oil industry under the following heads :—

(*a*) Improvement of natural palmeries by thinning and planting.

(*b*) The evolution of an improved hand method of extracting oil by means of a "cooker" and press.

(c) The offering of a subsidy under certain terms to any firm or individual willing to erect a mill.

(d) Inspection of produce for export.

It seems fairly clear that the best combination for Nigeria is fruit from native owned "improved" palmeries extracted by efficient moderate sized power-driven mills. Until prospective mill owners are assured of a reliable and constant fruit supply they will hesitate to invest the necessary capital. The problem lies in educating the local farmer to the advantages to be gained from selling fruit to a central factory with due safeguards as to price of the fruit. This development of education is likely to be slow, but, judging from the African's willingness to adopt new methods when shown to be to his advantage, will eventually come about. The oil palm industry of Nigeria should then be in a very strong position indeed.

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CANE BREEDING IN JAVA.[1]

Selection of Parent Varieties.

It has not been found possible to formulate precise rules for the selection of canes to be used as parents, owing to the extreme genetic complexity of all varieties. Every variety carries a large number of characters, both good and bad, and it is impossible to foretell exactly how these will be distributed to the offspring through hybridization.

Certain facts have, however, become apparent from studying the results obtained from crossings made over a number of years. These records have shown that crosses between certain parents consistently tend to give seedlings of greater promise than seedlings obtained from other crossings. This has come to light through the methods used in selecting seedlings. The hybrid seedling canes are subjected to a vigorous weeding out at the end of the first year after being planted out, and again at the end of the second year. Many seedlings of poor type are eliminated at the first selection, and at the second selection, types with low sugar content and types that give a poor yield of cane are discarded. The number of seedlings which comes through both selections is small. It has been noted that certain parents give offspring, a large percentage of which show up well in the selections. Other crossings produce seedlings, few of which survive even the first selection.

The parents which give rise to promising seedlings are relatively few in number, and are always either well known and tried varieties, or varieties which, though of a high general standard, have failed to come into general use on account of minor defects.

Hybridization for improved strains is, therefore, concentrated upon the large scale production of seedlings, using as parents, varieties which have proved their ability to produce high quality offspring.

Other Parent Types.

Apart from crosses which are made with the intention of producing seedlings of direct commercial value, crosses are also made, the offspring of which it is not anticipated will be of direct use in sugar production, but which it is hoped will prove useful as parents in subsequent crosses. This is especially the case when wild grass-like canes are used in breeding.

A certain number of crosses are also made each year between ordinary canes of foreign origin, the behaviour of which as parents is unknown. The performance of their offspring in the selections decides whether or not they are of sufficient merit for use as parents in the large scale work.

Breeding Stations of Varying Climate.

It has long been known that cane varieties differ considerably as regards their fertility and time of flowering, and that such are much affected by climate. It may be impossible to hybridize two varieties which are growing side by side, because they flower at different times of the year, or one may not even flower at all.

The production of crosses between such pairs of varieties was first made possible in Java in 1924, when in addition to the main breeding station at Pasoeroean, another one was instituted at Blambangan. Since then stations have been opened at Watesbeloeng and Labakroto. These stations are at varying altitudes, and enjoy varying climates. The flowering of early varieties is found to be delayed by planting at higher altitudes. The flowering spikes, or arrows, can be transported to stations of lower altitude and used in breeding operations for the production of certain crosses hitherto unobtainable.

General Principles in Cane Breeding.

For the direct production of improved varieties, only those types are used as parents which have proved their value in the production of seedlings of merit. Crosses between such parent types are made on a large scale. The making of random crosses is not considered to be of much value.

Success in cane breeding is often ascribed to chance, but by choosing the parents carefully on the basis of their past performance, the chances of producing exceptionally good seedling types are materially increased.

Another line, which has been productive of good results, has been the building up, by successive hybridizations, of polyploid forms of cane. The process is based upon differences in nuclear construction, which occur between different races of cane; especially as between cultivated and wild forms. This work has progressed hand in hand with precise cytological observation and research. R. E. H.

1 Summary of a paper by Dr. O. Posthumus in *Archief voor de Suikerindustrie in Nederlandsch-Indie*, 1928, No. 21.

RATIONALISATION.

By H. M. Leake.

I.

In the February number of this *Journal* appeared an article on rationalisation in its bearing on tropical agriculture. In the following series I set forth, at the request of the Editor, in expanded form the ideas therein contained. But if I am to make my meaning plain I must indicate in as few words as possible what I understand by the word 'rationalisation.' It is a word little understood in spite of its vogue at the present day and, in consequence, perhaps because, frequently misapplied. It is a word hardly capable of definition because it applies to a group of processes any one of which may, under any particular set of conditions, assume a dominant importance. All too frequently that dominant process is mistakenly assumed to be the only one and to sum up in itself the meaning of the word. If, therefore, I can offer no definition which would receive general acceptance, I can at least, for the sake of clarity, explain the interpretation which the word bears in the present article and which, if more widely accepted, would, in my belief, go a long way in checking mistaken application and consequent disappointment.

The confusion which has arisen on the subject is due, in large measure, to the alien origin of the word. That origin lies in Germany where the word was applied to post war industrial reconstruction. That was a very specialised use and perhaps it would have been better had the word retained that restricted meaning; but it has not and its application has been widened to embrace all forms of business enterprise. As was almost inevitable, in the course of this extension the word continued to emphasise those particular processes which characterised that particular movement. And herein lies a most potent source of misunderstanding.

Rationalisation is a means to an end and embraces all processes tending to achieve that end. But it is not always with that end in view that these processes may be applied. Herein lies a second source of misunderstanding for it is incorrect to apply the term to those processes except they be directed towards that end. This end is, therefore, worthy of a little study.

Undoubtedly the greatest desideratum in any form of production is stability; the stability which is given by an assured market for the goods produced at an assured price. The booms and slumps which have been the feature of so many markets may appeal to the few individuals who delight in the opportunities for gambles thereby offered, but they are an unmixed evil to those actually engaged in production itself. And the first stage in the road to that stability is an approximation between consumption and production. This is the point emphasised in Lord Melchett's definition of rationalisation which, perhaps, strikes more truly at the root meaning of the process than any other. But consumption is, and in the nature of things must be, variable, and production must be in like manner flexible if it is to be truly rationalised. Here we have the end at which rationalisation aims; production and consumption bound to each other by flexible bonds.

It requires no argument to show that these are not the conditions which prevail in business at the present time. Production only too clearly does not wait upon consumption. Goods are turned out in ever increasing quantities by the inexorable technical processes fashioned by man and they are thrust on an often unwilling consumer whose appetite has to be stimulated by subtle appeals through advertisement or by impassioned appeals of the commercial traveller. These are the conditions of intense competition under which life is hard for the producer who survives to carry on and many go to the wall. Herein lies the essence of Professor Macgregor's definition of rationalisation as a means for "the non-destructive elimination of the weak and the control ove the entry of new establishments." Here is recognition that productive capacity has outrun consumptive demand and adjustment is sought by means of reduced competition. Clearly a full solution is not to be found along these lines alone; Professor Macgregor himself only indicates this as a part, though an important part. With an expanding population unemployment can only result and unemployment spells reduced consumptive capacity. But some control of this nature is certainly one of the features of rationalisation.

Industrialism in its early days was a structure composed of small units. Technical progress had not yet developed the high power unit and the low power unit formed the core around which production crystallised. Further, the day of limited liability had not yet dawned and the financial organisation of large units of capital presented difficulties. Free competition was the agent by which production was adjusted to consumption and it resulted in the elimination of the weaker unit. In this process two features are noteworthy. Since the eliminated unit was small, no cataclysm resulted from its cessation of production. Again, consumptive demand was expanding almost as rapidly as production increased with, as a result, a low elimination factor. Over this scene an entire transformation has passed. With technical progress and the large power unit, productive capacity has increased enormously while limited liability has opened the door to financial units of large dimensions. Demand no longer waits on production but production tends to create demand. Flexibility is reduced to a minimum and competition becomes war to the knife; a war between gigantic units. The elimination of the weakest unit as the result of free competition can no longer be regarded with equanimity; the repercussions are too great. Such elimination produces a cataclysm of national importance.

One further point must be mentioned with especial regard to England. In the industrial development the natural advantages of coal as a source of power and iron ores in close proximity gave to England an advantage denied to others in the days when transport was in its infancy. In these favourable circumstances she built up her industrial supremacy. But technical progress has affected transport no less than other forms of activity and abundant supplies of the basic materials of industry have been found widely distributed. These are now cheaply transported to any portion of the globe in which a demand arises. This, and the exhaustion of her more readily acquired supplies, have lost that advantage to England. Industry has become world wide; tariffs are freely used to support a national and often irrational industry, and flexibility is sought in the dumping of excess products in any free market. Herein lies the ultimate field for rationalisation, an international field as yet only touched in a few cases by working agreements between the producers of similar products in different countries. It is a field not always realised to be, or classed as, rationalisation, yet it is the logical ultimate step in the process.

Rationalisation, then, in its broadest sense, is what has been described by Mr. Urwick (L. Urwick, *The Meaning of Rationalisation*) as a change of attitude towards economic problems. It is a recognition that, with the shrinking of the world as the result of facile communication, with the growth of productive output relative to man-power employed as the result of the advance in technical processes, free competition, the old method of adjustment between consumption and production, is too dangerous a weapon to be employed since, if employed, it does not react to the general welfare. Rationalisation, in its broadest and truest sense, is the attempt to find that organisation of productive enterprise which will achieve that object, the general economic welfare.

It is time to turn to the more practical aspect of rationalisation; the methods which have been proposed and employed for this purpose. At the World Economic Conference in 1927 rationalisation is defined as "the methods of technique and "organisation to secure the minimum waste of "either effort or material. They include the "scientific organisation of labour, standardisa-"tion of both materials and products, "simplification of processes and improvement "in the system of transport and marketing" with the object, as laid down by the Reichscuatorium fur Wirtschaftlichkeit (Board of National Efficiency) "an increase in the standard of living "by the provision of better and cheaper goods "in larger quantities." That is an industrial definition and it naturally emphasises the factors which play a major part in the industrial field. It is sufficient, however, to show that the process is a complex one and which particular one of the various factors is of major importance will depend on the conditions of the particular form of activity.

And now one word as to its dangers. Undoubtedly the small unit of production has small scope for rationalisation. It cannot effectively carry out any of the processes included in the above definition. It may retain its individuality but it must conform to the activities of those other producing units which supply the same markets. Actually the tendency is to merge these small units into large ones with loss of identity and the creation of a virtual monopoly, at first national and rapidly tending to become worldwide. Hence Sir Gilbert Vyle's definition in which he draws attention to the obvious danger and which reads as follows:—

"The conduct of industry in such a way that "the price of its products was fixed and, by the "aid of whole or part monolopy, the agreed "selling price was maintained without relation to "costs of production. The condition essential "to successful rationalisation was the absence "of competition, and, as all of them were "consumers, it was proper to enquire whether "such a method of systematising industries was "a good thing for the community as a whole."

The motive behind all commercial and productive enterprise is profit. The increased productive capacity already noticed has exceeded consumptive capacity with severe competition as the consequence. It is technical advancement and not the war that has produced this condition; the war has merely hastened the process. To meet that competition the small unit is unfavourably situated. Its overhead charges are relatively large; it cannot employ the technical skill that will keep it abreast of the rapid progress of the present day and it cannot create markets. In these and other directions the large unit is in an infinitely stronger position and, as long as profit remains the spur, the creation of larger and larger units is inevitable. On that Ixion's wheel is modern progress bound; to fail to follow means elimination. Rationalisation in its present day form is, then, hardly well named for it carries within itself the seed of its own destruction. But it is inevitable in the present stage when production is on a national basis. It becomes dangerous only when this is not recognised and it is accepted as offering the final solution of economic production. It is this narrower sense of the term that is accepted here; the steps that appear desirable to meet the ever growing competition created by a productive capacity in advance of consumptive needs. It is the practical question of the moment, the final stage in the automatic adjustment between production and consumption is hardly yet a matter for practical consideration.

II.

The driving force which is behind rationalisation is, as I have attempted to show, the advance in technical knowledge which has so increased the productive output relative to men employed that production exceeds consumptive capacity. Technical development has achieved its greatest successes in the industrial field and it is here

that the pressure has been most severely felt. The advanced nations of the world are all highly industrialised and the pressure is a matter of personal experience to the vast majority of the members of those communities. For this reason it is the pressure that receives most attention. But it is not in the industrial field alone that the phenomenon of excess production is found; it is present in equal intensity in the agricultural field though the silent role played by agriculture in the activities of most nations tends to mask the fact. Here, too, technical progress has played its part in creating the present situation, but that part has been less direct. In the steamship, the railway and the motor vehicle, technical triumphs in the field of transport, it has provided the means of throwing open vast, and hitherto inaccessible, areas to cultivation and of bringing the produce to the world's markets at a competitive price. The pessimistic prognostications of Sir William Crookes at the end of last century indicated a world shortage of wheat at the present day. They have been falsified, as the depressed markets with their superabundance of supplies witness only too clearly. But this falsification is not due to any material discrepancy in his estimate of consumption; that estimate was remarkably accurate. It is due to his failure to appreciate at their true value the extent of the areas which the development of transport would throw open to cultivation. And what is true of wheat is true of almost every class of agricultural product. Wide stretches of productive land remain both in North and South America and in Australia while the heart of Africa has hardly been scratched as yet. Much of this land lies in the tropics and tropical production is affected no less than that of the temperate zone; the opening up of the tropics has lagged behind and is only now being vigorously attacked. It is hardly possible to name a single tropical crop of any importance which is not at the present time suffering from overproduction. The position with regard to sugar is notorious; cacao, with the extending cultivation in the Gold Coast, coffee, as Brazil has cause to realise, and rubber all tell the same tale while the Manchurian production of soy beans seems likely to affect adversely other oil producing crops and especially coconuts.

Tropical agriculture shares with industry the phenomenon of overproduction and there is one other feature which the two hold in common. The competition which has resulted has assumed a national aspect. Of this, sugar may again be quoted as a notorious instance, the efforts to develop cotton within the Empire are a reaction to the same tendency. And so it is with other crops. There are, thus, at work the same influences which have been seen at work in the industrial field; production forging ahead of consumption with the inevitable competition; competition under the pressure of which the weakest will go to the wall. These influences are working along the same lines, the lines of nationality. Inevitably must those engaged in agricultural development in the tropics tread the path of rationalisation if they are to avoid that fate. It is time the methods to accomplish "the non-destructive elimination of the weak and the control over the entry of new establishments" were seriously considered. Unfortunately, as regards the British Empire, the urge is in the opposite direction. As an industrial country, dependent for her food on imports, she is forced to look around for export markets for her goods and in her overseas possessions she sees a comparatively undeveloped market which is less exposed to the competition of the remaining markets of the world. Hence the cry is for the opening up and development of these as yet undeveloped colonies. But they can only pay for the industrial products of England by export of products which must be mainly agricultural and can only overload the already overloaded markets. And, for a large number of staple agricultural products, those constituting the food supplies of humanity, the market is an inflexible one. If motors are cheap many will be tempted to keep two cars in place of one but no one will buy a second loaf on account of its cheapness when one satisfies his appetite. The most that variation in price will accomplish here is a slight increase in the consumption of one staple at the expense of another asis well seen in Northern India; where there is a large element of the population fluctuating between wheat and the coarser grains or pulses according to the relative price and its own purchasing capacity.

Overproduction of staple food materials will normally produce a drop in price disproportionate to the amount of overproduction and in this lies one reason why the adjustment of production to consumption is of even greater importance in agriculture than in industry. Owing to climatic reasons, for climate rigidly limits the possible range of cultures, and owing to biological considerations, for many of the cultures take years to mature, there is not the same flexibility in agricultural production as is found in industry in which, in a comparatively short time, a concern can turn from guns to ploughshares, from explosives to silk stockings.

Those processes which are generally included in the term rationalisation are, consequently, even more necessary in agriculture than in industry, and, owing to the national basis on which agriculture is conducted the practical aspect is the narrow one, the selfish aspect of avoiding elimination. Already a beginning has been made, witness the organisation of the Californian fruit trade and the various wheat pools that have been established. About these and similar organisations two points are noteworthy. In the first place they are on a national basis and only tend to emphasise the same trend of competition which was observed in industry. To this conclusion the Anglo-Dutch rubber agreement now under discussion will, if it matures, form an exception possible at the present stage of commercial evolution only because the industry is practically in the hands of these two nations alone.

Secondly, there are organisations to supply an export market, a type of organisation offering fewer difficulties than in the case of a local market. But many of these attempts are in the nature of crude experiments hastily conceived to meet the pressing need of the moment and do not strike at the root of the evil; and, lest I be misunderstood, let me say that I would exclude from this criticism the true co-operative organisations. A more searching enquiry than has hitherto been undertaken and a drastic reorganisation of productive enterprise is required if a stable position profitable alike to producer and consumer is to result. Tropical agriculture is no less concerned in this reorganisation than temperate agriculture and the path will be easier for two reasons. One, of which note has already been made, is that the wealth of tropical agricultural production lies in what are known as exchange cultures, cultures, the produce of which finds its way on to the world's market and is, therefore, raised for export. The second is that, in most tropical countries, these exchange cultures are of recent development. The systems under which they are raised, the systems of land tenure, are less rigid and less bound by legal trammels than those found in older countries.

But if reorganisation, or rationalisation, is the need of tropical agriculture, it must be a reorganisation suited to the conditions prevailing in that field of development. These conditions differ so materially from those of industry that it is not possible to accept blindly the lead given by industry. A preliminary enquiry into the pertinent factors of tropical agriculture is indicated. And here a difficulty arises. The conditions in the various countries are so divergent that it is hardly possible to summarise them adequately in a few words. But such a summary must be attempted. They are differences that owe their origin partly to historic, partly to climatic, reasons, in so far as climate has affected the density of the indigenous population.

Broadly speaking, tropical agriculture, in so far as exchange cultures are concerned, is conducted on three principles. There is the individually owned estate, generally in alien possession, and worked on the plantation system. It is a copy in all essentials, including its individualism, of the form of production found in the home country. It is the earliest form historically and characterised the early settlements in the New World. It arose at a time, when humanitarian sentiment was less general than it is to-day and possession of the land, where no effective opposition was forthcoming, was the natural reward of the conqueror. Originally a system founded on slavery, it has survived the emancipation of a century ago. A like development has taken place in more recent times in Kenya, Rhodesia and the Uplands of tropical Africa generally, where the paucity of the indigenous population left land in excess and alien settlement could take place without material injury to that population. Typically it is a system of personally owned estates worked in the early days by slave, and later by hired, labour. Individualism is, as has been noted, the characteristic of this form of development; small units which are placed at a disadvantage in the economic struggle of the present day.

In the second place there is that later development of production by commercial companies registered under the Company laws. It is a class of development which owes its rise to importance to the introduction of limited liability in the middle of last century. It secures its facilities for operation mainly through the establishment of settled government. One of the first functions of Government in a new country has always been the establishment and record of rights in land. Land to which there are no claimants passes to Government by which it is placed at the disposal of development companies by sale or lease. Company development is, therefore, a comparatively recent venture chiefly in those territories, lacking at the time of acquisition, claimants to the entire land surface. Rubber and tea in Ceylon, rubber in Malaya, and fibre in East Africa, are typical examples of this form of production. Sugar offers another example but here the urge to company formation is largely the cost of the manufacturing plant which, in its modern form, is beyond the means of most individuals.

Lastly there is native production, production by the indigenous population on its own holdings which are usually of small size. Here, lack of capital limits output to produce which requires little or no preparation to fit it for the market. In large measure the exchange cultivations are composed of short season crops, cotton, oil-seeds and even natural growths such as palm-oil, since these yield a quick return for the labour expended. But perennial growths are not infrequent as is exemplified by cacao in West Africa and rubber in the Dutch East Indies. The unit of production is small, consistent with the general practice of peasant holding and requires to be bulked before it comes to market. Where peasant production of exchange cultures occurs, therefore, will be found a trading community concerned, not with production directly but with handling the produce.

This form of production owes its existence to two very different causes. The lack of a virile population in the New World capable of resisting the inroads of the early adventurers led to conquest with transfer of the rights in land in accordance with the spirit of the times. Contemporaneously in the East the adventurers possessed no such preponderant strength over the denser and more civilised populations and the first footing that was obtained in such countries as India, was that of traders in native produce. Or, as in West Africa, it was in addition the unkindly climate which forbade settlement and limited contact with the outside world to one of trade. In modern times it is sentiment that has dictated the policy of native production.

Along these three lines has tropical development proceeded. They are sharply contrasted neither in localisation, for in many territories

native production exists alongside the plantation systems, nor in class of product. Where, as in the case of sugar, an expensive preparatory process is required before the product is rendered suitable for the world's market, native production plays a small part though the particular form of sugar acceptable to the Indian still permits a large area to be grown on this system. But in the case of many products competition exists between the three systems. As of especial note may be mentioned cacao, where the native production of the Gold Coast is advancing by leaps and bounds to the detriment of plantation cacao of the West Indies and Central America; rubber, where native production in the Dutch East Indies forms a serious competitor to the plantation rubber of that country, Ceylon and Malaya, and palm-oil where, curiously enough, the reverse process is seen in that it is plantation production in the Dutch East Indies which is a growing anxiety to the native production of West Africa.

It is these diverse systems of production of one and the same product which renders the problem of rationalisation in tropical agriculture so complex. If a sane policy of rationalisation is to be found it must embrace all three. It must be based on some common denominator of all three and the discovery of that common denominator is the primary task.

(*To be continued.*)

PROBLEMS OF IRRIGATION.

An article under the above title is contributed by Prof. H. B. Wilsdon to *Nature* (Vol. CXXV, p. 674). Prof. Wilsdon deals primarily with the consequences of irrigating arid land without due consideration and interpretation of the prevailing conditions. Terrain, soil and sub-soil, climate, design of irrigation channels, the method of distribution of water, and the habits of the cultivator may all influence the final condition of a soil under irrigation. The danger of any irrigation scheme is that factors which in the early stages are producing excellent results may be building up a state of affairs which will render the irrigated soil unfertile and unfit for further use. Two main conditions of the soil may occur. Excessive irrigation, particularly in regions where wet and dry seasons alternate and natural drainage is poor, may result in a rise in the water-table and subsequent water-logging of the soil. Deficient irrigation, particularly in arid regions where evaporation is high, may produce a saline soil which is toxic and of poor physical condition.

Drainage is the chief controlling factor. Where irrigation tends to be in excess, or may be supplemented unexpectedly by rain, adequate drainage will limit the water-table within a narrow margin. Where salinity is the danger, a good drainage system will allow a sufficient flow of water through the soil to prevent the accumulation of salts. A combination of irrigation and drainage appears essential for the success of all such schemes of the future and should be designed at the outset. Under present conditions in areas devoid of drainage, the difference between the amount of irrigation water necessary to produce water-logging and the inadequate amount resulting in salinity is small. Abnormal weather conditions may irretrievably upset the balance at any time. Drainage will permit a much wider range in the amount of water which can be applied without producing harmful effects and will allow for abnormal conditions.

The immensity of the problems involved may be gathered from the fact that in the Punjab some ten and a half million acres of flat alluvial land previously considered unfertile, are irrigated by a supply of water which averages 25,000 cubic feet per second throughout the year. Of these ten and a half million acres, three and three-quarter million acres are threatened with water-logging.

The situation is being attacked systematically and fundamentally. Rainfall, irrigation and water-table data have been analysed. Correlation has been established between the rainfall and the amount of irrigation and the subsequent height of the water-table. The general trend of the water-table has been established and its level can be predicted with considerable accuracy. The results have shown that irrigation has been in excess of requirements during certain periods of the year, followed by a dangerous rise in the water-table. The supply of water is now being modified. It seems possible that, in the future, a study of meteorological dates and a careful control of irrigation will enable the water-table to be kept practically constant over any uniform area.

These investigations have been supplemented by a gravity survey of the underlying strata. Details of the natural drainage system of this vast bed of alluvium which extends to a depth of 6,000 feet have been obtained. They will undoubtedly assist materially the formation of the artificial drainage system which will have to be introduced if irrigation is to be continued in this area.

H. H. C.

BANANAS.

The Behaviour and Diseases of the Banana in Storage and Transport.

By C. W. Wardlaw and L. P. McGuire.

In this paper published in our July number, reference was made to the work of Huelin and Hicks on the acceleration of the ripening of bananas by means of suitable concentrations of coal gas (Interim Report, *Journ. Counc. Sci. & Ind. Res.* Australia, Bull. 30, Nov. 1929.) By an unfortunate oversight this was omitted from the bibliography and the authors now take this opportunity of acknowledgment.

PROBLEMS IN BIOLOGICAL CONTROL.

The Gap in the Sequence of Generations in *Artona catoxantha*, the Coconut Leaf Moth of Malaya.

Introduction.

INSECT pests, normally under the closest control, are liable, from time to time, to break out. In this paper the inter-relationship of certain insects affecting the coconut palm in Malaya is discussed. One of these, *Artona catoxantha*, a small olive brown moth belonging to the family of *Zygaenidae*, occasionally occurs as a pest of first magnitude in Malaya, Borneo and Java, where its larvae feed on the under side of the leaves of the coconut palm. In outbreaks of this insect certain peculiar phenomena were observed, and one of these in particular, the gap in a sequence of generations and its connection with the outbreaks, will be dealt with and suggestions put forward as to the causes which bring this about.

The investigations which led to the theories put forward here resulted from experience gained in the work of introducing parasites of *Artona catoxantha* into Fiji. These parasites were intended to be used against another coconut pest belonging to the same order, *Zygaenidae*, but not closely related to *Artona catoxantha*, in fact, actually belonging to a different sub-family, an introduction which, however, proved extremely successful.

The Levuana Moth.

Description.

The Fijian pest (*Levuana iridescens*) is a small dark purple moth about five-eighths of an inch across from tip to tip of the expanded wings. Its larva is much the same in appearance as that of *Artona catoxantha*, and like that species feeds upon coconut and certain other palms including Royal, Sago and Areca, showing perhaps a slight preference for the first two.

Location.

The insect was first definitely recorded in 1877 by Horne who visited the group and noticed that coconut palms in the neighbourhood of Suva and in the adjoining Rewa district suffered intensely from the effects of the larvae of a small purple moth, which, of course, could be nothing else but this species. The writer was informed that the pest has made its appearance at Ba on the other side of the island in 1880 and his informant was very positive that it was not there in his boyhood, but stated that it appeared after the hurricane in that year.

Although the moth had never been found outside of Fiji, and no other species belonging to the genus is known, there are several reasons for supposing that it was an introduction from overseas and not an endemic species. The chief of these are :

(1) Its peculiar distribution in Fiji. It was for 60 years confined to one island, yet having accidentally reached others it showed, by its ability to establish itself there, that conditions for its existence were favourable throughout the rest of the group.

(2) There was a native tradition that coconuts at one time produced heavily on the island on which it was found—Viti Levu—and this tradition is supported by Seemann's statement, written in 1860, that coconuts bore well on all the smaller islands of the group and around the coast of the larger ones, excepting round about Viwa and Bau on the island of Viti Levu. Seemann visited at that time several parts of Viti Levu but does not seem to have seen traces of the pest elsewhere. In fact his statement is decidedly clear on this point.

(3) There are also some earlier missionary records (1847), one of which states that coconuts elsewhere did well up to about 600 feet and no exception is made of Viti Levu.

(4) The fact that no native parasites of the insect have ever been found is also highly suggestive that it is an accidental introduction.

So far as any theory can be put forward it was probably introduced sometime previous to 1877. This introduction taking place in the neighbourhood of Bau which was the first port of call for vessels arriving in the group for many years, particularly for the sandal wood boats, which in the '40's and '50's visited there in some numbers. It is possible that it was introduced on some ornamental palm and there is little doubt that it will eventually be found as a rare insect, possibly in the Solomon Islands, whence much labour was obtained in the '70's, or if it came in a sandal wood boat, Southern China would be the most likely place.

Control.

No local parasites had been recorded. There were, it is true, certain predators, including *Pentatomidae* and jumping spiders, but these produced little effect.

As far back as 1916, Knowles, then Superintendent of Agriculture, began to look abroad, in the hope of finding a suitable controlling agency, with a view to its introduction into Fiji. The most promising insect from which such introduction could be hoped was *Artona catoxantha*, an insect well known in Malaya. At that time, however, few observations had been made upon it and little was known as to the agencies which normally held it in check. The opinion seemed to be that such parasites as were present were of little value and that the control was mainly brought about by fungus agency. In this they were looking to what brought about the clearing up of an epidemic outbreak, and it must be pointed out that such agencies are not necessarily and, in fact, frequently are not, those which normally held an insect in check. Acting, however, upon that opinion,

Knowles on two occasions imported cultures of the fungi which were supposed to be the parasitic agency at work, and about 1921 some of these were liberated in Fiji. It is not known whether any benefit was obtained. Little mycological work of this nature has been done in Fiji and nothing was known regarding the endemic fungi attacking lepidopterous larvae present in Fiji, previous to this introduction. In any case, fungi require certain specialised conditions such as moisture, and crowded conditions of their host, in order to be of much use. They can, however, be valuable in cleaning up an epidemic, when semi-starvation brought about by vast numbers and moist atmospheric conditions, render them susceptible to such attacks.

When in 1920 the writer joined the Department of Agriculture enquiries regarding the insect parasites of *Artona* were begun and opinions obtained as to the probabilities of such parasites attacking a moth so distinct from *Artona* as was *Levuana iridescens*. Opinions on this subject differed greatly. Australian specialists held the view that a search should be made for the original home of the Fiji pest, rather than attempt the introduction of parasites of even a closely allied species. On the other hand, the concensus of London opinion was, that some at least of the *Artona* parasites would be likely to attack this insect. In view of this divergence of opinion and the difficulties and expenses attendant upon the introduction of material from a country so far away as Java or the Malay States, it was decided first to survey the little known Solomon Islands and the New Hebrides in the hope of finding there the home of *Levuana* itself. With that object in view the writer worked through some hundreds of coconut estates, nipah and sago swamps, along the north coast of New Guinea, through the Bismarcks, Solomon Islands and the New Hebrides. Whilst many new and interesting coconut pests were discovered, no trace of the very characteristic feeding marks of a *Zygaenid* caterpillar was found. Since then, investigations in New Britain by Taylor, revealed the presence of a species of *Alpina*. While more recently, Paine discovered a larva, feeding upon banana, near Faisi in the Shortland group, which might have been a species of *Levuana*, although smaller than *Levuana iridescens*, and it seems probable that *Levuana iridescens* itself will eventually be found upon some native palm in these little known islands.

Whilst the writer was upon this mission to the Solomon Islands, Mr. A. Despeisses had arrived from Western Australia to act as Superintendent of Agriculture and he decided to employ an Australian Entomologist, first to search for the original home of *Levuana*, and failing that, to go on to the East to import parasites of *Artona catoxantha*. This entomologist spent some months in the Torres Straits and finally went on to Malaya and, thence, to Java. In this latter country an outbreak of *Artona* was in progress when he arrived and he decided to attempt to bring parasites of the species from that outbreak through to Fiji in cold storage, an attempt which failed.

The seriousness of the position had, however, so alarmed the Fijian planters that they had approached the Colonial Office for assistance, and Dr. Tothill, who had had experience in handling *Tachinidae*, certain members of which group were known to be the most important of the parasites of *Artona catoxantha*, was appointed to take charge of the whole work.

Dr. Tothill decided upon four lines of attack in approaching the problem:

(1) To continue the efforts to introduce *Artona* parasites.

(2) To continue the search for the original home of *Levuana*.

(3) The introduction of insectivorous birds.

(4) The use of high power spraying machines, making use of sea water.

In this scheme of work the writer was instructed to carry out the introduction of the *Artona* parasites, Taylor was to search for the original home of *Levuana*, an Australian ornithologist was sent to Ceylon to obtain certain birds, and a high power sprayer was imported.

To deal with the last two proposals, first, the use of arsenicals with sea water was found to be efficient, but became a matter of transport and practical economics and was abandoned. Next in the matter—birds—a number were imported from Ceylon, but in view of the success which had at that time been achieved with the *Artona* parasites, none of these were liberated.

The search for the original home of *Levuana* was also abandoned for the same reason.

The writer proceeded to Java and the Malay States, finding no outbreaks of *Artona catoxantha* at that time running at either place. The Acting Entomologist at Kuala Lumpur, however, suggested certain places where it might be possible to find the insect in small numbers, places which had recently been the scenes of severe outbreaks. At one of these, Batugajah, the insect was found to be present and was for five months under observation, always in very small numbers. In this locality it seemed to be existing in a number of small local foci; varying in numbers from month to month. Shortly after the discovery of this small centre of infection, the writer returned to Kuala Lumpur and was there joined by Mr. Taylor who was on his way to Cochin China to try to find the original home of *Levuana*. The writer suggested to him that he should visit Batugajah and there see *Artona catoxantha* under what then appeared to be normal control. A letter of introduction was given to the Agricultural Inspector stationed there, to whom the larvae discovered had been shown. Shortly after Taylor's arrival at that village a native came in and reported to the Inspector that there was a major outbreak at Kuala Dipang, some 18 miles

away, and it was at this outbreak that certain observations were made, and also from which the material was obtained and shipped to Fiji, with most successful results in overcoming the *Levuana* menace.

Before proceeding further it may be of interest to mention that the method adopted on this occasion, as in several other of our successful insect introductions, was to use large cages, containing young growing plants, upon which thousands of parasitised larvae were placed.

In this particular case it was found impossible to load them in sufficient numbers, quickly enough, immediately before shipping, so quantities of leaves, covered with larvae, were cut down and placed into boxes and closed up. These boxes and the cages of growing palms were railed to Singapore, and thence shipped by a direct steamer to Fiji and carried on deck. Mr. Taylor accompanied this shipment and, as soon as he was at sea, he opened up those boxes which contained the drying leaves with the masses of larvae and transferred these to the growing plants, thus enormously increasing the quantity of material that it was possible to ship.

After having seen Mr. Taylor and the consignment off at Singapore, the following three months were spent mostly at Kuala Dipang and Batugajah, watching the developments of the major and minor outbreaks, and many interesting observations were made.

Artona catoxantha Epidemics.

The outbreak of *Artona catoxantha* at Kuala Dipang was found to be confined to a few acres, the affected portion being sharply divided off from the non-infected, but the pest was apparently spreading outwards from the centre. That centre was so utterly destroyed as to appear as if a fire had swept through it, yet 100 yards or so away the trees were absolutely clean and beyond this point not a specimen of the pest in any stage could be found. Nor could any specimens or traces be discovered anywhere else in Malaya, except in one or two places like Batugajah, which had been the scenes of some recent epidemic outbreak, similar to the one under review. Of course, this does not mean that the moth does not exist elsewhere. This it must do, because outbreaks occur practically every year, often far removed from any recent record, but the point is that normally the insect is one of the scarcest attacking cultivated crops, yet, it periodically breaks away from the highly efficient agencies which control it, to become a pest of the greatest magnitude.

The second and most remarkable feature about these outbreaks lay in the fact that of all the vast numbers of the insect present within the affected area, which must have run into millions, all lay within a certain definite period as regards their development at any one time. That is to say, they were all within a certain age limit of one another. Prolonged search never showed a specimen outside of that definite age limit and it was impossible at any one time to obtain all stages of the insect. The maximum difference in ages between the oldest and youngest specimen at any one time was found to be 20 days leaving about 16 days unrepresented. There was always a definite gap in the sequence of generations and this definite gap is, apparently always present in epidemic outbreaks.

It had been shown by Gater that the possible variation in the time of development in any batch of eggs was from 34 days up to 45 days. That is to say, that there was an individual variation or, a possible individual variation of about 11 days. This means that the descendants of any one batch of eggs should, in three or four generations, link up, and all stages be present at any one time, as was the case in Fiji with *Levuana iridescens*. These, however, showed no tendency to do so, but continued generation after generation with the well marked gap in a sequence of generations, representing a period of about 15 days.

Another interesting feature observed was that the moth is ready to oviposit 35 to 38 days after having itself commenced its existence as an egg, so that one would naturally expect the first eggs of a new generation to appear about 35 days after the first eggs of the preceding one. This, however, proved not to be the case and it was approximately 45 to 46 days later that the next generation began to appear.

In all these outbreaks vast numbers of parasites are present. They show, however, no tendency to swamp their hosts, and it is not until the advent of the wet monsoon which brings new factors into play that the outbreaks normally clear up.

These facts were so striking and remarkable that it seemed certain that a single cause was at the base of all, and later it was concluded that the outbreak itself was definitely connected with the same agency, that agency which was bringing about this gap in the sequence of generations. Observations showed that of the different parasites present in these outbreaks numbering 12 or 14, one species, a *Tachinid*, *Ptychomyia remota*, the one which was so successfully shipped to Fiji, was always the dominant species, far outnumbering any of the others and, in fact, all the others put together, although in this particular outbreak an *Apanteles* was numerous in the earlier generations. This *Apanteles* subsequently grew scarcer and all the other parasites tended to die out as the generations passed, leaving *Ptychomyia remota* more dominant than ever. In Java another *Tachinid*, *Dejeria albiceps* takes the place of *Ptychomyia remota* as the dominant species and has a very similar life history. It seemed probable that the key to the cause of the gap lay in the inter-relationship between the dominant parasite and its host, and this opinion is based on the following facts:

(1) *Ptychomyia remota* takes 19 or 20 days from the time that it commences life as an egg until it is itself ready to oviposit.

(2) *Artona catoxantha*, its host, takes 35 or 36 days from egg to egg.

(3) *Ptychomyia remota* and its hosts of any one batch of eggs emerge, as adults, at approximately the same time.

(4) But the parasite requires fourth instar larvae on which to oviposit, which means larvae that arise from eggs deposited 16 to 20 days previously.

In consequence, the parasites of any one batch of eggs must either find an earlier generation of larvae big enough for their purpose or scatter to find alternative hosts, or failing this, they must wait until the offspring of their own generation of hosts are sufficiently large for ovipositing upon. Once the gap in the sequence of generations is formed, there will be no earlier brood available, and, in the absence of alternative hosts within a certain radius, the fly will have to either scatter beyond the distance that its offspring are likely to be able to return in numbers, or wait until the descendants of its own generation of hosts are sufficiently large before it can oviposit. This latter it is quite capable of doing. It is then, however, so eager to do so, that it rapidly empties itself upon the first larvae to reach the required size, wasting its eggs, by placing a number upon one caterpillar only capable of supporting one parasite; and then having no eggs left for those larvae which mature later. These latter escape entirely, producing another brood of moths which, however, owing to the total suppression of those larvae which first reached the fourth instar, will appear six or eight days later than the normal life cycle of the moth—35 days—would lead one to expect. Also, it follows, as the fly is capable of ovipositing 19 days from the time when it was itself an egg, that 19 days after the first fourth stage *Artona* larva is parasitised, a new brood of parasites will begin to be on the wing ready to suppress any stragglers of their own generation of hosts which may still be about, and the brood of moths is thus cut off at both ends and kept within a period of about 19 or 20 days. This 19 days represents the period when the parasite is within its host, followed by a second period of 16 days, plus the time represented by the suppression of the earlier portion of their own last generation, say 24 days, when all the parasites are on the wing, the hosts being in a stage unsuitable for parasitisation.

It would also happen that once this gap has been established that any other parasite, whose attacks are confined, as they mostly are, to a special stage, would also be faced with a long waiting period on the wing, and those surviving this period would immediately attack the first of the next generation to reach the required stage, accentuating still further this gap. It thus appears that once the gap is established *Ptychomyia* will tend to maintain it indefinitely and since the presence of the gap means the escape of a large number of the host, there grows up an intense population of both moths and parasites, the latter never overtaking their host and an epidemic outbreak occurs. So much for the theory based upon the facts observed in Malaya.

It is now necessary to turn to Fiji where *Ptychomyia remota* had been so successfully transported and established, and see whether its behaviour there lent any support to the suggestions above enumerated.

The theory of the sequence of generations as applied to the Levuana moth.

The introduction of this parasite into Fiji was extremely successful, despite the fact that its new host belonged to a distinct sub-family of the *Zygaenidae*. It spread rapidly throughout the affected islands and, in 12 to 15 months it completely cleared up its new host everywhere except in three localities. Except in these three localities the moth was as impossible to find as *Artona* normally is in Malaya. But in these three localities a gap in the sequence of generations appeared, similar in every way to the *Artona* gap, and for three years, in two out of the three, the pest continued in varying severity, but always with the well marked gap in the sequence of generations.

Further, as with *Artona*, the earlier members of each brood were suppressed, and there was a similar extension of the time from the first eggs in any one brood to the first eggs of the next, to that which one would expect from the life history of *Levuana*, similar to the extension met with in the *Artona* outbreaks. The formation of the gap within the sequence of generations in Fiji showed that *Ptychomyia remota* was undoubtedly its cause as well as its maintenance, and the position of the outbreaks in which the gap was formed gives a key to why this is brought about.

Two of these Fijian cases were on small islands a few acres only in extent, and the third consisted of a group of coconuts situated in an area of cane and grass. All were isolated from any mixed vegetation likely to support a varied fauna, and therefore in none of them were alternative hosts for the parasite likely to be found. It is known that *Ptychomyia remota* will attack a variety of caterpillars and it seems probable that under normal conditions *Ptychomyia remota* and its main host, which is undoubtedly the *Zygaenid*, occur in small numbers, fairly widely scattered, and that the resulting parasites of each generation of one brood either find a few of an earlier generation locally or mostly scatter, meeting with a reasonable number of suitable hosts, either of that or some other species within a limited area, the resulting parasites of the next generation being not too far away to come back in sufficient force to maintain a more or less even pressure over the whole area, upon the few scattered families of *Artona* or *Levuana* as the case may be. This pressure will, of course, fluctuate from time to time. When, however, the supply of alternative hosts fails within a certain radius, a brood of parasites will be likely

to arise which will have either to fly beyond that radius, in which case they will be too far away to come back in numbers to maintain the pressure upon the next generation, or, they must wait until the next brood of their own hosts are sufficiently large for their purpose, when they will immediately empty themselves, and later maturing ones will escape and a definite gap will have been formed. It is probable, of course, that it is not in every case that such a gap will become an epidemic outbreak. Parasites may come back to strike it a little later, before it has grown too big for them to have any effect, but unless they do so the brood will go on with a tendency for the gap to lengthen out and become more marked, and once this happens the numbers must increase until an epidemic occurs, so that there arises a state when egg-laying covers about 20 days. The first eight or ten will be smothered by parasites and the second ten escape entirely.

It will probably be asked how such a position, once established, could be brought to a close. In Malaya the advent of the wet monsoon always terminates the outbreaks. It is uncertain in what manner. Fungus undoubtedly plays a part, also the mechanical effect of the rain may destroy some numbers.

In Java, however, advantage has been taken of the gap to bring artificially an outbreak to a close. This is done by cutting and burning the leaves from the affected trees, at the time when the dominant parasite is on the wing, this being when the hosts are in such a stage that the majority of them are either eggs or larvae feeding upon the foliage, and in this way a disproportionately vast number of parasites are left, which swamp the comparatively few larvae which have escaped the cutting of the foliage. It seems possible that in nature something of this kind occurs occasionally, unfavourable conditions to the host, such as an outbreak of fungus, or wet weather, occurring when the bulk of the parasites are on the wing, would occasionally lead to a reduction in the numbers and compression of the ovipositing period to such an extent as to enable the parasites to swamp it, but the writer has no personal observation beyond the Java experience on which to base this.

Before closing, a few actual observations made at Kuala Dipang in Malaya can be given which formed the original data of these remarks.

In June of 1925 an outbreak was at its zenith, millions of *Artona* were present. On 30th June, parasitism of fourth and fifth instar larvae was almost total. There were, however, small unparasitised larvae present, which on 8th July had reached the third and fourth instar, and, of these not more than 20 per cent. were attacked, whilst the host of the generation seemed to escape entirely. In the next generation on 18th August parasitism was not only practically total as regards fourth instar larvae, but large numbers of these larvae carried many parasites, as before younger unparasitised larvae were present. These on 26th August were in their fifth stage and it was then found that they had almost entirely escaped. The few that were parasitised carrying newly laid eggs, undoubtedly from parasites of their own generation of hosts.

It will thus be seen that in each generation the parasitism is confined to that portion which matures within a definite period of dates, whilst there is another portion on which no check whatever occurs and upon which there is no limit to the numbers to which it can increase, and, in fact, an epidemic outbreak such as we have been discussing is brought about.

BRITISH GUIANA BALATA.

THE only balata produced within the Empire is the West Indian variety from British Guiana. In quality it compares favourably with, and in some respects is superior to, the balata from French Guiana; but it is questionable if it is better than the produce of Dutch Guiana. In recent years the output from French Guiana has only been comparatively small.

The balata is sent to the coast in the rainy season, as the rivers then permit transport. After selection in Georgetown it is shipped mainly to Great Britain, where it is used in the manufacture of cables and for other electrical work. It has a fine insulating power, and is impervious to moisture in its finished condition. British Guiana's production is considerably smaller than that of Dutch Guiana or South America.

Balata is coagulated latex of *Minusops Globosa*, commonly known as the bullet tree, which grows in British Guiana on the alluvial lands of Berbice and between the Demerara and Essequibo rivers. Great Britain, the chief manufacturing country for balata belting, golf balls, and submarine cables, is also the principal consumer. Balata is shipped in bales, and is sold on the London market by private treaty. The supply is somewhat limited owing to the inaccessibility of the forests and often to lack of labour.

The trees are tapped by incisions one and a half inches wide and ten inches apart, made in feather stitch pattern up the trunks of the trees, the latex running from cut to cut into a calabash placed at the foot of the trees. Yields vary from one gallon of latex a tapping, which is equivalent to form 4 lb. to 5 lb. of dry balata, and a tree 20 inches in diameter yields about 2 lb. The latex is put into gourds and taken to depôts, where it is poured into shallow vessels and exposed to the air to coagulate gradually. It is then hung up to drain until sufficiently dry for shipment. Block balata from Venezuela is obtained by boiling the latex. Extremely wet or dry seasons are unfavourable to the crop, as during a wet season a large producing area is flooded and in a dry season the flow of latex is poor.—(*The Times Trade and Engineering Supplement*, 24th May.)

AGRICULTURAL CO-OPERATION.

THE Indian cultivator, a man of small means in a land of precarious rainfall, stands naturally in need of credit, and the co-operative institutions in India—which now number over 100,000, with a working capital of £75 million—are performing a valuable service. The problem, however, with which the co-operative movement is faced is to secure skilled and constant supervision over the finances of the societies. The danger is less of dishonesty and embezzlement, though this also occurs in India as in England, than of laxity and consequent misuse of credit. What the ryot does not readily grasp is the essential duty of punctuality in repayment, so far as his crops and other income allow: and until this novel idea has become firmly settled in his head, a trained adviser, with knowledge alike of co-operative principles, of banking rules, and of the language and habits of the peasant, should be frequently beside him to discourage extravagance and to instill the lessons of prudence. The absence of such trained men, and the devolution of all guidance on an unstable group of elected villagers in a union, was one of the leading causes of the troubles of the co-operative organisation in Burma, as revealed in a recent report of a special committee appointed by the Burmese Government.

In Burma, the growth of societies, chiefly of urban and rural credit and of cattle insurance, has been steady and encouraging since the introduction of the Co-operative Act in 1904; there were nearly 4,000 credit and 400 insurance societies on the register at the end of 1928. Over them stood nearly 600 local unions of societies, 21 central banks, and the Burma Provincial Co-operative Bank at Mandalay. The working capital amounted to £3,750,000. In recent years, however, a growing reluctance on the part of the peasant-cultivators to repay their debts to the small village societies, which finance their agricultural and domestic needs, has raised to an uncomfortable figure the percentage of "overdues" in the provincial and the central banks. The object of the rural unions was to secure, by a mutual guarantee, the loans advanced to their affiliated societies from the banks, and the committee members of a union should have denounced to their own general meeting and to the bank the name of any recalcitrant village society, while exercising all possible moral and social pressure on the defaulters. The social ideals of an Oriental country do not always include punctuality in repayment, and the duty of recommending so unpopular a virtue proved most unwelcome to the leaders of the unions. Consequently, little or nothing was done, and the example of unpunished default was infectious. The Registrar is provided with a staff of official inspectors, whose functions cover propaganda and supervision, and who should, on the complaint of an unsatisfied creditor, move him to bring a society compulsorily under liquidation. Here, too, the report of the Calvert Committee to the Burmese Government shows that there has been undue leniency, and insolvent societies have been allowed to remain on the register in the idle hope of their improvement.

The result is a crisis. The Burma Co-operative Bank in 1928 recovered only one-sixth of the principal debt and one-half of the interest due to it; a loss on the year's working was avoided only by writing up the investments to their market value; and it became necessary for the Government to guarantee a temporary overdraft of the Co-operative Bank with the Imperial Bank of India, and to accept responsibility for the full repayment of all deposits. The loss to the provincial revenues is officially estimated at Rs. 30 lakhs (£250,000). The Burma Co-operative Bank is to be wound up, several of the central banks will probably follow suit, at least three-quarters of the insurance societies will be closed, and 1,400 out of 3,800 rural credit societies are already in liquidation. The co-operative movement in Burma is not dead, but will require to be built up again on sounder lines. In the meantime, the shock is severe.

To what causes is the disaster attributed, and how is the restoration to be carried out? In the first place, there is no suggestion of bad faith. Audits have been imperfect, auditors' warnings have been neglected, local supervision has lacked courage and thoroughness, but dishonesty, with the exception of minor incidents, is not alleged. The chief weakness has been an excessive reliance on the Guaranteeing Union, a group of rural representatives who possessed neither the character nor the inclination to be strict at the price of unpopularity. Co-operation among Asiatics differs from that of Europeans in no point more sharply than in the capacity for facing an unpleasant duty and for insisting on rules of business. Certain Indian provinces, therefore, have laid on the official inspectors the duty of reporting to the financing bank on the condition and "credit worthiness" of its debtor societies, and of stimulating the latter to fulfill their obligations. Eager to evoke the power of co-operative self-government, the Burmese left this burden to the unions, which failed to shoulder it.

The unions are now to be abolished. The inspecting staff, however, when working among a simple peasantry, must also be occupied in constant teaching and guidance, and for this purpose they must themselves be steeped in co-operative knowledge. A fuller course of training is in future to be given to the Burmese inspectors, equipping them as sympathetic guides of the villagers and as real sources of authority. Whether their opinion should be demanded by the financing banks on the fitness of applicant societies for further credit is a question on which the Government and the special committee have

disagreed, the former rejecting the recommendation of the latter that such help should be sought. Theoretically it is undesirable, but in practice the banks will find it difficult to obtain from elsewhere the intimate information which they need. Villages are remote and villagers taciturn, communications are poor. If the policy of extending mortage credit to the peasants, for clearance of old debt and for opening up new land, be adopted as is now proposed, special mortgage institutions will no doubt be required, and the ordinary co-operative banks will then confine themselves to advances of shorter term. Loans for the period of one agricultural crop are easily controlled, since full repayment will normally be made after the harvest, but intermediate loans for cattle-purchase, &c., will still call for information over a longer period. The banks may perhaps have recourse to the stronger step of asking the Registrar to liquidate an unpunctual society, but will be in the same difficulty, without the advice of his staff, in judging beforehand the real wisdom of an advance for which application has been made. Other Indian provinces foresaw at an early stage the need to strengthen village societies by the help of a trained supervisor. In Bombay the latter is often a non-official, who takes charge of a circle of societies and spurs them to activity. In other parts a full-time official is more usually employed, whether in the service of Government, of the co-operative banks, or of an organising and auditing union. The policy of high training has been carried farthest in the Punjab, which appoints Indian graduates of rural sympathies and requires a probation of 18 months in the field and study, culminating in an economic test of post-graduate standard. Several of the inspectors thus trained have proved capable, in addition to their ordinary duties, of conducting intensive or extensive economic inquiries into the welfare of the people, either under the Registrar of Co-operative Societies or under the Board of Economic Inquiry. It is held that an agricultural credit policy should be based on an exact and intimate knowledge of peasant economy, without which the most skilled economist, in advising the cultivator, is working in the dark. More than 100 of these specialists are now serving under the Punjab Government, and the best of them are able to grapple with the puzzling and multifarious problems of a country, in which all economic conditions, and above all the fortunes of the cultivator, are being affected and re-shaped by the change from a subsistence to an export system of agriculture.

The organisation, both of the cultivators and of the artisans and clerical classes, has thus been developed, with the assistance of the Government, until, not only credit societies, but also agricultural purchase and sale, cattle-breeding, and land improvement institutions are found in half the villages of the province. There are now no less than 20,000 societies of every kind, with a membership of 600,000 and a working capital of £12,000,000. Over the primary societies are 120 central banks and a provincial bank, the latter serving also as the financial agency for a dozen mortgage banks and attracting funds for their use by the issue of 25-year bonds. A thorough audit of the primary societies is annually conducted by the employees of the Provincial Union, and of the secondary bodies by chartered accountants. A European banker has been appointed by Government as financial adviser to the Registrar of Co-operative Societies, not only because a small proportion (about 1¼ per cent.) of the working capital has been lent by Government for special purposes, but also because the moral responsibility of the State for a movement so closely intertwined with the life of the people renders financial skill and caution indispensable. The managing officers and the directors of the central banks and the Provincial Bank gladly welcome technical advice, and though certain of the minor banks have from time to time been closed for lack of wise policy, no central institution in this area has ever failed to pay its creditors in full or has required financial subsidies from the State.

Surprise has sometimes been expressed at the ability of Indian peasants and artisans to accumulate considerable funds from their own savings, and there is no doubt that, when the earliest societies were founded 25 years ago, the prospect of such thrift appeared to be dim. Confidence has nevertheless attracted the more long-sighted villagers towards the credit banks, and a sum of £3,250,000 represents the share money and other savings of the members in the Punjab. The remainder of the working capital is derived from deposits in the central banks, drawn, to a great extent, from the professional and clerical classes, who prefer to place their money in a secondary and well-managed institution rather than in a virtuous, but not highly educated, village society. Minor peculations in the latter undoubtedly occur, but are not numerous or alarming if it be remembered that 92 per cent. of the people cannot read or write; the central banks, on the other hand, are financially sound, and maintain for the most part a good level of accountancy. The banks, no less than the primary societies, manage their own affairs, being advised by the official staff in difficulties and checked in case of irregularity. Such a supervision, which would be irksome and superfluous in a European community, is desirable and convenient where business methods are less standardised and social pressure renders impartiality less easy to attain.

The clearest conclusions from the comparison of the stricter and the looser systems are that simple men in an Oriental country require prolonged guidance in their economic dealings from trained experts, and that financial laxity should be immediately corrected before it becomes habitual. It is on these principles that the more successful Indian provinces have erected their co-operative organisations, and the less fortunate will, if patient and courageous, be enabled to rebuild their own.—(*The Economist*, Vol. CX, No. 4, 507.)

HURRICANE WARNINGS.

WITH the exception of Grenada and Trinidad the West Indian islands lie within the hurricane zone. At the beginning of the hurricane season it will perhaps be of interest to residents in those islands to refer to the nature of these storms, to the paths which they ordinarily follow and the signs by which the approaching hurricane may be known.

Information of this sort used to appear from time to time in *Agricultural News*, where it was customary to use a diagram showing the rotation of the cyclone and the direction of its movement. The following notes are largely taken from one of these articles which appeared under the heading "Hurricane Warnings" in Vol. XIX, page 244.

It is understood that the hurricane has two forms of motion. The motion of rotation, in which winds revolve around the centre at a very high velocity; and the motion of translation, in which the whole revolving mass moves along a path from the place of the origin of the cyclone. The nature of these two motions may be well understood by reference to the motion of the spinning top; it will be seen that the rotation may be very rapid around the central axis, while the top itself may remain in one spot or may move along from place to place. The rotation of the winds in a hurricane is counter clock-wise. In the hurricane, as in the spinning top, the revolving mass may move from one place to another.

Usually West Indian hurricanes approach the islands from the Atlantic, that is, from East or East-South-East, and travel towards Cuba and the American coast, where the path curves northward and finally eastward, so that the storms pass out into the North Atlantic. This progressive motion across the West Indian islands is comparatively slow, ranging from about seven to fourteen miles an hour. An observer, therefore, knowing the general trend of the hurricane's path, may, by observing the direction of the wind and its changes, form a very good idea of his position as regards the centre, and whether the centre is coming directly towards him, or is passing on the north or on the south side of him.

If the direction of this wind remains fairly constant in a direction North-North-East or North or North-North-West, the probability is that the centre is directly approaching. Conversely, when the wind's direction remains South-East, South-South-East and South, the centre is moving directly away. Where the motion of the wind changes from North-East to East-North-East, East and East-South-East, the centre is passing on the South side of the observer. When the direction changes from North-West to West-North-West, West and West-South-West, the centre is passing to the North of the observer.

These rules apply in the West Indies only. From these an observer can anticipate fairly exactly what may be expected to happen, and—a matter of great importance—he is able to recognise when the centre has passed, and the storm may be expected to begin to abate. The violence of the wind increases as one approaches the centre; at the centre itself there is an area of calm. When this centre passes over any particular place the direction of the wind suddenly changes, and the wind, after its passing, begins to blow violently from exactly the opposite direction from that from which it blew before: this is a feature of considerable importance in West Indian hurricanes. The barometer falls rapidly as one gets nearer and nearer the centre, so that the barometer affords a means of marking the approach of the centre, and the probable distance that it is away, while the changes in the direction of the wind afford clear indications of the line along which the centre is travelling. In judging the direction of the wind it is best to note the direction in which the lower clouds are moving: this is better than observing weather cocks or flags.

It is worth noting that in the West Indies—the rule does not apply elsewhere—in describing the direction of the wind, when one employs the term South as South-South-West or South-East or in any way uses the term South, the centre has passed and conditions may be expected to improve. On the other hand, the dangerous position is indicated by those winds which involve the use of the term North, as for instance such winds as North-North-East, or North, or North-East.

The first indication of an approaching storm is frequently a heavy swell breaking in heavy surf along the shore; these waves come from the direction of the centre of the approaching storm. They may be noticed many hours, sometimes a day or two, before the storm passes. The next indication is usually some disturbance and unusual movement amongst the higher clouds, coupled with unusual light, often a coppery glare at sunrise or sunset, particularly the latter; the wind is then unusually irregular and puffy, and the atmosphere moist and oppressive. The next indication is a fall in the barometer, and then the observer may feel certain that a cyclone is in existence.

It is worth noting that cyclones may, and do exist, in which the wind is rotating with only moderate velocity; they present all the characters here referred to save that not having violent winds they do not cause much damage, it is only when the wind blows violently that a cyclone becomes a hurricane.

These facts are readily grasped and appreciated; a knowledge of them is of great service to West Indians, enabling them to take such precautions as are possible to protect themselves and their property from approaching storms and relieving their minds of great anxiety when they are able to recognise that a threatened storm has passed.

The Editor will be pleased to send a gratuitous specimen copy of *Tropical Agriculture*, post free, to anyone interested in tropical development.

MYCOLOGICAL NOTES.

"Rhizoctonia solani" (Kühn) on Cotton in Trinidad, 1929-30, by J. West.

During the summer of 1929, the Mycology plots were under a heavy crop of Bengal Bean (*Stizolobium deeringianum*). This was cutlassed and ploughed in in mid-November. The plots were ridged up immediately and planted with Sea Island cotton. Later they were replanted with Sea Island and Million Dollar cotton. Both soaked and unsoaked seed were used. Germination showed above 90 per cent. under test. Heavy mortality, due to *R. solani*, occurred with both types of cotton.

The following factors probably aided this infestation :—

1. Decomposing trash in the ridges offered an ideal medium.
2. Some of the planting was done on top of the ridges, where the soil "puddled." Seed planted too deep.
3. Heavy rains immediately after sowing.
4. Tendency of the soil to "bind" when drying out.

Infections were of three types :—

1. The germinating seeds were killed before they emerged above the soil crust.
2. Young seedlings were attacked at ground level—the majority dying, but a few recovering.
3. Occasionally three to four weeks old plants were attacked and died.

An experiment was carried out to test the pathogenicity of *R. solani* on the farm cover crops and on maize. Cigarette tins filled with sterilized sand, watered with sterile water, and inoculated with three day old potato wedge cultures, were kept in the laboratory at constant temperatures. Frequently the surface of the sand was covered with a white aerial growth of the fungus. The following table shows that only maize (*Gramineae*) was not susceptible of the various plants tried.

These factors interacted to produce a state which both delayed growth on the part of the seedlings, and induced an active state of growth of the part of *R. solani*.

Results : Seedling Infection by *R. Solani* (Kühn).

Host.	*Column A.*	*Column B.*	*Column C.*	*Column D.*
	Per cent.		*Per cent.*	
1. Cotton : Million Dollar (Treated H_2SO_4)	12.12	100	5.6	83
2. Cotton : Million Dollar (Untreated)	12.12	100	5.6	83
3. Cotton	18.18	100	9.9	100
4. Phaseolus aconitifolius	30.30	100	15.15	100
5. Phaseolus mungo	24.24	100	12.12	100
6. Woolly Pyrol. (*P. mungo*)	30.30	100	15.15	100
7. Pole Lima Bean. (*P. lunatus*)	12.12	100	1.6	17
8. Black Kidney Bean. (*P. vulgaris*)	—	—	0.6	0
9. Red Kidney Bean. (*P. vulgaris*)	20.20	100	10.10	100
10. Phaseolus aureus	60.60	100	28.30	93
11. Red Canavalia	10.12	83	6.6	100
12. White Canavalia	12.12	100	6.6	100
13. Mottled Bengal Bean. (*Stizolobium* spp.)	12.12	100	5.6	83
14. Black Bengal Bean. (*Stizolobium* spp.)	12.12	100	6.6	100
15. White Bengal Bean. (*Stizolobium* spp.)	17.18	95	9.9	100
16. Barbados Cowpea. (*Vigna sinensis*)	18.18	100	7.9	78
17. Brown Eye Cowpea. (*Vigna sinensis*)	18.18	100	9.9	100
18. Dolichos spp.	60.60	100	28.30	93
19. Pigeon Pea. (*Cajanus indicus*)	18.18	100	9.9	100
20. Centrosema pubescens	28.30	93	9.15	60
21. Tephrosia toxicaria	40.40	100	11.20	55
22. Tephrosia candida	59.60	98	25.30	83
23. Chick Pea. (*Cicer arietinum*)	—	—	0.6	0
24. Soy Bean. (*Glycine soja*)	—	—	0.9	0
25. Sunn Hemp. (*Crotalaria juncea*)	59.60	98	30.30	100
26. Calopogonium mucunoides	59.60	98	19.30	63
27. Maize. (*Zea mais*)	0.18	0	9.9	100

Column A : Ratio of plants killed to plants inoculated.
Column B : Percentage infection.
Column C : Ratio of seedlings growing to seeds planted. (Control tins).
Column D : Percentage germination.

Die-Back Disease of Cacao.

A severe and widespread die-back disease which has rendered the cultivation of cacao unprofitable in many parts of the Philippines, and is characterized by the death of the terminal portions of the branches, a generally unhealthy appearance, and the virtual absence of fruits (*R. A. M.* VII, p. 143), is stated to be caused by a species of *Colletotrichum*. It has been partially controlled by suitable cultural measures, combined with the excision of infected material and painting the stubs with asphaltum.—(*Review of Applied Mycology*, Vol. IX, Part 1.)

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Ultrafine Soft Granulated Sugar.

The object of this invention is to provide pure granulated sucrose in crystals that are finer and softer than any granulated sugar heretofore produced. In preparing such sugars by this process a sucrose solution either of cane or beet having a density of 75 to 85 per cent. solids at 17.5° C. (preferably containing 80 to 82 per cent. solids obtained by melting commercial sugars of sufficient purity, or by concentrating in vacuo high purity white liquors from refinery char filters, or by diverting high purity granulated syrups from previous hard granulated strikes from the usual refining process) is passed through a heater and raised to a temperature between 140° and 212° F., preferably 160 F., to melt false grain, or if substantially grain-free it may be passed directly to a suitable cooling vessel.

The solution is then rapidly cooled in any suitable apparatus, preferably by spraying the solution through an air chamber at atmospheric pressure against a cooling surface or jacket, to approximately 95° to 130° F., preferably from 110° to 120° F. The exact amount of cooling to obtain the best results is governed by the density, purity, and temperature of the liquor or syrup being treated and the size of the crystals desired. This rapid cooling causes a substantially instantaneous, complete, and regular grain setting.

The solution is then discharged into any suitable crystallizing apparatus, in which it is slowly agitated for a period of from 30 minutes to six hours, preferably for about two hours, while the temperature of the mass is slowly reduced to approximately 80° to 90° F. It is then spun in a centrifugal to free the crystals from the mother liquor and carefully washed with a fine spray of water or low pressure steam to further purify the crystals, after which the crystals are conveyed to horizontal driers of conventional structure where they are dried substantially absolutely free from moisture. The mother liquor thrown out of the centrifugal machine may be retreated for the preparation of a second crop of crystals.

The sugar produced by this process is of substantially absolute purity, containing approximately from 99.5 to 100 per cent. sucrose by weight. It is many times finer than the finest granulated sugar hitherto produced, the individual crystals being fine enough to pass for the major part through a 35 to 40 mesh screen. The crystals are relatively soft, and unlike commercial soft sugars, are substantially free from any adhering film of syrup.—(*Facts about Sugar*, Vol. XXV, No. 16.)

Tests with Kroog and Sweetland Presses.

Comparative operations with Kroog and Sweetland presses were made at a carbonation factory in Java. The Sweetland press used had a filtering surface of 64.6 square metres, the Kroog press 40 square metres with 30 frames. From the results it appears that with good filtering juices the Sweetland press has about twice the capacity of the Kroog, and even this excess capacity may be increased ten per cent. if there is no back pressure in the filtered juice lime and if the cakes on the frames do not grow together before the optimum time of filtering has expired. The tendency of the Sweetland press to form cakes of uneven thickness with rapidly filtering juices results in unsatisfactory sweetening-out, particularly if the cakes grow together. Slow sweetening-out at low pressure gives the best results with both presses. With cakes of normal thickness in the Sweetland press it is preferable to follow the dirty juice directly with the sweetening-out water instead of first blowing out with air.

The question as to which type of press is to be preferred depends in any given case on the effectiveness of the sweetening-out process. Simplicity and labour saving are in favour of the Sweetland.—(*Facts about Sugar*, Vol. XXV, No. 16.)

* * *

Conductometric Determination of Ash in Refinery Syrups.

It has been shown that the conductometric formula which corrects for differences in the proportions of various anions in raw cane sugars can, under comparable conditions, be used for the determination of ash in syrups and molasses produced in raw sugar factories. For refinery syrups, however, the factor in the formula has to be changed to suit each individual class of product of each individual refinery. It has been found that the abnormal behaviour of refinery products is due to a change in the proportions of the various cations through treatment with bone-black. An additional conductance determination in the presence of alkali makes it possible to establish a second correction and to develop a unified formula for refinery syrups. The percentage of ash in these products equals 0.01757 $(1.33\ K+498.3-0.091\ K_1-0.5\ K_2)$, if 0.5 grams of syrup plus 4.5 grams pure sucrose are dissolved to 100 ml. K is the specific conductance $\times\ 10^6$ of the solution; K_1 that of 200 ml. solution plus 5 ml. 0.25 normal hydrochloric acid; and K_2 that of 200 ml. solution plus 5 ml. 0.25 potassium hydroxide solution, all at 20° C. If the addition of sucrose is omitted the formula is 0.01640 $(1.064\ K+434.4-0.089\ K_1-0.25\ K_2)$. These formulas do not apply to syrups and molasses from the raw sugar factory, for which the original conductometric formula gives better results.—(*Facts About Sugar*, Vol. XXV, No. 15.)

THE OIL PALM INDUSTRY.

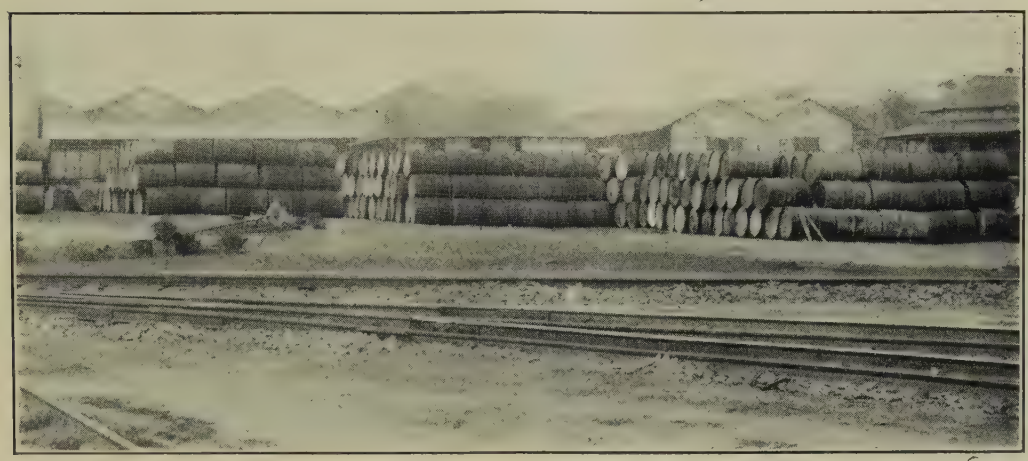

FIG. VI.—*Steel drums for best grade palm oil. The storage sheds of the Huileries du Congo Belge in the background.*

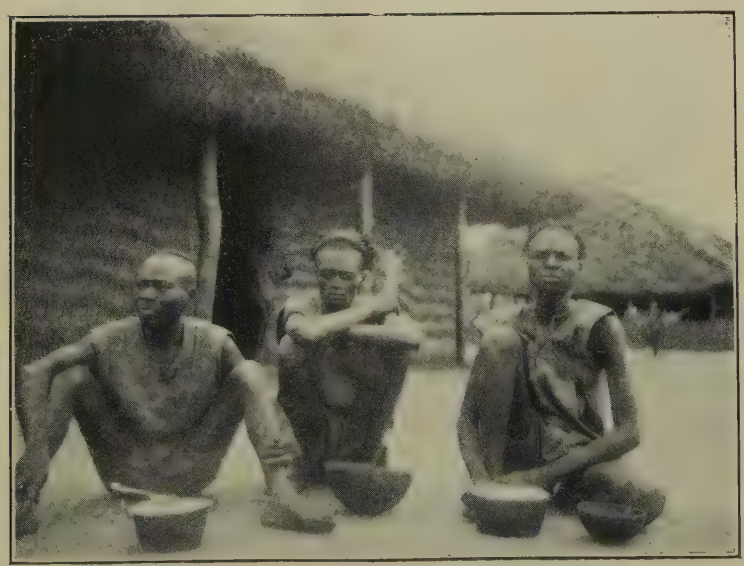

FIG. VII.—*Labour types. French Equatorial Africa.*

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TROPICAL WORLD NOTES.

Nyasaland.

The development of Nyasaland is seriously hampered by the poverty of its communications and the resulting high freight rates. Cotton was first grown about 1900, and its cultivation on European estates extended more or less rapidly until in 1917 the record crop of 8,600 bales was exported. Yields per acre, however, dropped steadily until, when prices fell, the cultivation became so unremunerative that it was practically abandoned. Cotton production by natives on their own gardens was almost dying out in 1923 when the Government granted the sole right to buy native grown cotton in Nyasaland to the British Cotton Growing Association. The production figures in bales of 400 lb. each are for 1922, European 3,976, native 631; and for 1928, European 292, native 4,164; while the total 1929 crop is estimated at 4,900. Cotton in Nyasaland has to face a wide range of conditions. It has been established by experience that the Nyasaland Upland variety, the survivor of the numerous types of cotton tried out when the industry was first started, does best at elevations below 2,000 feet. This means that cotton-growing on a commercial scale has been confined to the Shire Valley and Lake Shore areas. Research work carried out by the Corporation indicates considerable possibilities for cotton in Nyasaland. Stations have been established at Makwapala on the Palombe plain at an elevation of some 2,000 feet and at Port Herald on the Lower Shire. At the former, cotton must be sown as early as possible and at the latter it is best grown as a late-planted crop. A new station is being established at Domira Bay to study the cotton problems of the Lake Shore areas.—(*The Journal of the Textile Institute*, Vol. XX, No. 12.)

* * *

Costa Rica.

According to a report by F. N. Cox issued by the Department of Overseas Trade, coffee and bananas in 1928 formed over 91 per cent. of the value of the exports of Costa Rica, the United Kingdom easily maintaining its position as the chief country to which exports were shipped. The 1928 coffee crops amounted to 18,841 metric tons, and sold at an average of £134.78 per metric ton, a price slightly lower than that obtained during the previous year (£134.88), which is believed will remain a record for many years. The withdrawal of the contracts for extension of banana planting caused a great deal of uncertainty as to the future of this industry and no extensive new planting has taken place resulting in a decrease of exports. The planting and export of bananas from the Pacific Coast is, however, slowly increasing but the growers find it difficult to obtain regular ocean transport for their bananas. Cacao exports have showed a considerable increase over the previous year, while sugar exports have vanished altogether.

Tanganyika.

The annual crop reports for 1929 received from the several agricultural provinces of the territory contain several items of general interest. In Mwanza, increased agricultural staff and the large number of sub-stations, for demonstration and multiplication of proved varieties of crops, with seed distribution to natives, together with the instruction for ploughing, have made the value of such work more marked in this province than in any other in the Territory; but tribute must be paid to the superior intelligence and willingness to learn of the major tribes of the province. In Bukoba, difficulty is still found in the establishment of cotton growing among the natives of the Biharamulo district, where the British Cotton Growing Association, at the request of the Government, have erected a ginnery, but the efforts are continuing, for this crop provides the cash-crop for the district which the natives require. Three of the districts of the Tabora province now possess their agricultural farms for demonstration and the production of select seed which is conducted by the Native Administrations as an extension of the Agricultural Department's Station at Ibadakuli. Ploughing instruction has been extended, especially in Nzega; and the experiments were continued with drought-resistant fodder crops from other countries with a view to providing food for native stock during the dry season. In Kigoma the establishment of coffee in the Kasulu highlands is proceeding slowly but satisfactorily. In Mahenge the experimental cotton crop in the Songea area was not a success owing chiefly to late planting, but is to be continued in 1930 with more effective supervision. Attention is being concentrated in Songea upon tobacco and cotton as cash-crops. In addition, robusta coffee has been planted in nurseries with the object of distribution of the seedlings amongst natives, to provide an additional cash-crop. In Lindi, a new agricultural experiment station was established. In the Eastern Province the experiments at the Morogoro and Rufiji agricultural stations were continued and the possibility of mulberry silk production examined by an expert agriculturist. In Tanga tea has now been grown for three years in the Eastern Usambara hills on an estate which is the pioneer of this crop. The crop being found to flourish, there is every prospect of tea becoming an important industry. In the Iringa Province the prospect for tea in the Rungwe area continues to be flourishing and experimental plantings of tea have begun in the Eastern Highlands of this province. An ordinance to provide for the inspection and grading of produce to be exported from the Territory was prepared during the year in order to maintain and improve the quality and reputation of the export of the Territory. This ordinance (The Produce Export Ordinance, 1929) was published; but will not come into force until a date to be promulgated by the Government. At present, it is made chiefly for the regulation and control of the Bukoba native-grown coffee.

REVIEWS.

Silvicultural Notes on the more important Timber Trees of Trinidad and Tobago.

By R. C. Marshall. *Trinidad Government Printing Office.* Price 2*s.*, pp. 48.

This is an admirable little publication, which should be found very useful by landowners, not only in this island, but elsewhere, where conditions are at all similar. The author is the Conservator of Forests in Trinidad, and is a true "Man of the Woods," for most of the information with which the book is packed, has, he tells us, been obtained at first hand.

In the first chapter, Captain Marshall deals with the general silvicultural characteristics, *e.g.*, root systems, rates of growth, tolerance of shade, need for drainage and so on, of the common trees of Trinidad, and this information will enable the prospective planter to decide on the most suitable kinds to plant, either pure or in mixed forest. Chapter II deals with the actual formation of woods, natural or artificial, and Chapter III carries the story on to the maintenance of the forests, concluding with some sound advice about thinning. The last chapter gives detailed information about 27 important timber species, including all those which fall into the two first classes of the Crown Land Forest Produce Rules, as well as one or two other trees.

Half a dozen photographs add to the value of the book which is well and clearly printed, is of a convenient size to slip into the pocket and contains a few blank pages for notes. The agriculturist, especially in the tropics is so often directly interested in tree planting, for shade and shelter or for revenue purposes, that he will find this a useful addition to his library.

R. C. W.

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The S. A. Sugar Year Book and General Directory, 1930.

Compiled and Edited by H. O. Andrews pp. 310. Price 2*s.* 6*d.* (postage 6*d.* extra).

The first half of this book sets out a complete list of all the sugar factories operating in Natal and Zululand. As each factory is listed, particulars such as capital, names of the Directors and Factory Staff, description of the Factory plant, &c., are given. The second half is devoted to information useful to South African sugar producers and consists of copies of Agreements, Reports, Constitution of South African Cane Growers Association and the like, together with a certain amount of statistics and tables. As a whole, the book is an excellent production, well got up and well bound but one or two printing errors were noticed, which, however, do not lessen the book's value to any extent. The South African sugar industry is to be commended on the lead it has taken in this direction and it is sincerely hoped that other sugar producing countries will follow in publishing a Sugar Year Book.

J. G. D.

Fungous Diseases of Plants.

Dr. Jakob Eriksson. 2nd Edition. 526 pp. 399 Figs. *Ballière, Tindall and Cox,* 1930. Price 35*s.*

This book is an English translation of the 1927-28 German edition, with the insertion of a small amount of more recent material. It contains a description of the more important diseases of European economic plants, and so it is entirely concerned with non-tropical crops.

As may be expected, the style of the book is similar to that of the first edition. The diseases are arranged according to the classification of the pathogen concerned, and a host index is included as an appendix. The descriptions of the diseases are somewhat scanty, and are followed by the usual control measures and list of references. Many of the numerous figures are new.

Although the "Mycoplasm" theory has obtained no support from the majority of modern mycologists, Eriksson still persists in advancing his theory with determination.

A. K. B.

BOOKS RECEIVED.

We have to acknowledge the receipt of the following books :—

BACTERIOLOGY.

Bacteriology, A Handbook on Fundamentals. Stanley Thomas, 2nd Edition. *McGraw Hill Book Co.*, pp. 302. $3.00.

SUGAR TECHNOLOGY.

The South African Sugar Journal Year Book H. O. Andrews.

The South African Sugar Journal, Durban, S.A., pp. 310.

ACKNOWLEDGMENT.

We have also to acknowledge with thanks the following books which have been presented to the Library :

The Colony of Fiji, 1874-1929, 2nd Edition. Presented by The Government Printer, Fiji.

India in 1928-29. J. Coatman. Presented by the Secretary of State for India.

Recent Advances in Preventive Medicine. J. F. C. Haslam. Presented by Dr. Mary Beattie.

Silvicultural Notes on the more important Timber Trees of Trinidad and Tobago. By R. C. Marshall. Presented by the Author.

The Editor is prepared to consider signed articles for publication in *Tropical Agriculture.* Such articles should normally vary between 1,000 to 6,000 words and may be illustrated if desired. Rates can be obtained on application to the Editor.

COLLEGE NEWS.

Mrs. Evans sailed for England on 4th July by the s.s. *Coronado* and expects to return in the middle of October.

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Professor H. A. Ballou, Commissioner of Agriculture, sailed by the s.s. *Lady Nelson* on 2nd July for a tour of inspection of the Leeward Islands and returned on 24th July by the s.s. *Lady Drake.*

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Amongst recent visitors to the College were Doctor R. Dorel, Chef du Service Veterinaire de la Guyane Française; Dr. L. P. Edwards of Columbia University; and Brigadier H. S. N. Winterbotham, C.B., C.M.G., the Director of the Colonial Office Ordnance Survey.

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Congratulations are offered to Mr Eliot de Pass on the occasion of his Knighthood, the announcement of which appeared in the Birthday Honours List. Sir Eliot de Pass is Chairman of the West India Committee, and has been one of the Governors of the College since its inception.

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The 1929-30 session of the College came to a conclusion in the third week of June. Most of the post graduate students returned to the United Kingdom on 20th June by the s.s. *Camito* whilst the remaining students dispersed to their homes in the neighbouring Colonies in the following week.

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Mrs. J. G. Myers left Trinidad by the s.s. *Lady Nelson* on 29th May for a visit to the North West District of British Guiana where she was engaged in Ethnological studies. Mrs. Myers returned to Trinidad by s.s. *Lady Nelson* on 1st July and proceeded to England by the s.s. *Coronado* on 4th July.

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The following members of the West Indian Conference that recently met in Trinidad to consider the revision of the Canada-West Indies Trade Agreement of 1925, visited the College on 29th June and were conducted round by the Principal; Hon. A. E. Barton, Trinidad; Mr. D. G. Leacock, Barbados; Hon. E. K. Walcott, Barbados; Hon. W. M. Wigley, St. Kitts; Hon. N. Scott-Johnson, Antigua; Hon. W. M. Grant, St. Vincent; Hon. C. H. Rennick, Grenada.

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The Principal sailed for Jamaica on 12th July by the s.s. *Ariguani.* His visit is being made at the instance of the Secretary of State and is the result of correspondence that has taken place between the Colonial Office and the Government of Jamaica on the subject of research measures to be adopted against Panama disease in bananas. It is hoped to be able to so co-ordinate the Jamaica programme with that of the College banana research scheme which has been operating for some time, that unnecessary duplication and overlapping may be avoided. The Principal will leave Jamaica on 1st August for Montreal. He will stay in Canada for about 12 days, endeavour to visit several Agricultural Colleges and Institutions in the Dominion, and also investigate certain matters connected with the fruit and produce trade. He hopes to return by s.s. *Lady Drake,* leaving Halifax on 22nd August, and to inspect the work of the Agricultural Departments in the Northern Islands *en route,* arriving in Trinidad on 4th September.

OBITUARY.

THE College has learned with deep regret of the death of Mr. William F. Bushe, a Director of Messrs. Gordon, Grant and Co., Ltd., of Port-of-Spain, Trinidad. Mr. Bushe had recently undergone two operations in England, on account of head injuries which he received while playing Cricket and Rugby Football. He will be remembered, especially by past students, as an excellent scrum-half, a clean thorough all-round sportsman, and a sincere friend. We extend our sympathy to his relations on their bereavement.

THE COLLEGE EXPERIMENTAL SUGAR FACTORY.

OWING to the regrettable accident to the Professor of Sugar Technology (Mr. W. Scott) which took place two days before "crop" commenced, the programme had to be considerably curtailed. The research programme had to be practically suspended and all efforts concentrated on giving the necessary training to students.

Details of this year's grinding operations at the Sugar Factory are as follows:

Days grinding	21
Hours grinding	180.17
Tons cane ground	503
Cane hour	2.79
Cane: Sucrose per cent.	13.91
Fibre per cent.	13.18
Normal juice: Brix	19.18
Sucrose	16.33
Purity	85.14
Tons sugar	55
Tons cane/ton sugar	9.12

One Fourth Year, and three Third Year Students attended the classes, and one additional Student took a Special Course. No Overseer-Cane-Weigher was employed because of the short run and his duties were taken care of by the Third Year Students.

The crop available was short and yet proved sufficient to give the Students very valuable experience in the manufacture of sugar and factory control. The sugar made consisted of yellows, greys and seconds, together with a small quantity of factory molasses, and no difficulty was experienced in disposing of the crop in the Colony, local institutions, such as the Constabulary Canteen, taking a good supply of the better quality.

The working of the factory was in charge of Mr. J. G. Davies, the Assistant Sugar Technologist, and Mr. C. T. Watts, College Engineer, and the operations were completed with a minimum amount of dislocation.

G. E.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (*c.i.f.* per cwt.) :—

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
28th May	6	9	10	9
4th June	6	10½	10	6
11th June	6	10½	10	6
18th June	6	7½	10	4½
25th June	6	4½	10	3
2nd July	6	6	10	3

During the period under review there appeared at one time a prospect of better prices, owing to reports of a Russian demand for sugar, and rumours of concerted action to restrict production. The improvement in price was of a temporary nature, and the market soon relapsed into the apathetic condition to which it is becoming accustomed. The total visible supplies are considerably higher than during the two preceding years at the same date.

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COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :

	American Mid.	*Egyptian F.G.F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
23rd May	8·67	13·85	24·50	38·00	24 50-26·00
30th May	8·58	13·65	24·50	38·00	25·00-26·00
6th June	8·34	13.15	24·50	38·00	9·04-17·00
13th June	7·98	12·75	24·50	38·00	11·50 25·75
2nd July .... (local)	7·57	—	24·50	38·00	—

Prices have declined still further, due principally to favourable weather conditions in the cotton belt. The general crop condition is reported to be slightly better than average. The general bad state of trade continues to exercise a depressing effect. The Liverpool market for lower grades is particularly bad owing to the disturbed political situation in India. There has been rather more enquiry for Sea Island at steady prices.

COCOA.—The cocoa market continues lifeless with prices easier than a month ago notwithstanding the fact that the statistical position has improved.—(*By courtesy of The Cocoa Planters' Association of Trinidad, Ltd.*

* * *

COFFEE.—Imports for May, aggregating 65,993 cwt., were considerably below last year's figures of 96,024 cwt. Prices have improved, the demand for Jamaicas being firm at 200*s.*, while Costa Rica Middling and Santos averaged 145*s.*, and 70*s.*, respectively. Kenya Good Middling averaged 110*s.* but the demand is good for the higher qualities. 18th June. (*Times Trade and Engineering Supplement,* 21st June, 1930.)

* * *

TEA.—Prices have declined, the tone of the market being irregular. Supplies have been of an inferior quality which has tended to depress prices. Imports for May were two million pounds less than last year but deliveries also declined, and stocks which totalled 215,037,482 pounds at the end of May, are still on the high side. Deliveries for the year to date show a promising increase over last year. With the commencement of July, interest will be centred on the new season crop. Latest weekly averages are 18.07*d.* for Ceylon, 15.08*d.* for Indian, and 10.07*d.* for Java. – (*Times Trade and Engineering Supplement,* 21st June.)

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—28th May, $6\frac{1}{8}d.$; 4th June, $6\frac{5}{8}d.$; 11th June, $6\frac{1}{16}d.$; 18th June, $6\frac{1}{16}d.$; 25th June, $6\frac{1}{16}d.$ The market has shown further weakness, the primary cause being the large increase in Malayan shipments for May which totalled 49,039 tons. United Kingdom stocks, now 102,936 tons, show a considerable increase over last year and, in the absence of any increase in the average rate of use, a weak market is the inevitable result. It is anticipated, however, that manufacturers' demands will increase by the autumn.

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BANANAS.—The price of Jamaicas to wholesalers is £1 10*s.* per ton higher on the fortnight at £24 delivered or £23 10*s.* delivered nearest railway station ; the price to retailers is unchanged at 10*d.* to 1*s.* per dozen. There is a very good demand for Brazilians which are unchanged at £22 delivered nearest railway station.—(*West India Committee Circular,* 12th June.)

* * *

LIME PRODUCTS.—*Lime Oil :* No further sales of Handpressed have been reported, but the value remains at 50*s.* per lb. There is rather more enquiry for Distilled. *Lime Juice :* Concentrated remains neglected. Raw is unchanged at 3*s.* for good.—(*West India Committee Circular,* 12th June.)